AN INTRODUCTION TO PSYCHOLOGY

BY

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PREFACE

SHORTLY after the appearance of my *Psychology* in 1904[1] I began to receive requests from teachers to prepare a briefer volume on the same general lines. This I finally agreed to do, but fulfilment has lagged so far behind promise, that despite the continued popularity of the older work, it seems no longer appropriate to attempt a mere digest of it. The present book accordingly represents an entirely fresh survey of the field, and attempts to set forth simply and concisely the more important principles of general psychology. Some comment upon the relation of the two books to one another may be of interest.

The prompt welcome accorded the earlier work was presumably due to the novelty of certain of its features, which have since been adopted in greater or less degree by other authors. It emphasized for the first time, so far as I am aware, the distinction between structural and functional methods in psychology. It adopted and consistently utilized an essentially biological point of view in its interpretation of mental life, this position being reflected in part in the arrangement of the topics to exhibit the progressive stages of adjustment. It presented, provisionally to be sure, a definite and teachable system, which gave students who mastered it a sense of control over the material, enabled them to observe and think psychologically for themselves and—not least important—afforded them a terminology and a point of view which rendered the litera-

[1] Fourth edition, 1908.

ture of the subject easily accessible. Such changes as appear in the present text simply reflect alterations of emphasis and points of view which the development of the science has rendered necessary.

The structure-function distinction still seems to me significant. But it is no longer a matter of acute controversy and so requires a less militant treatment. Polemic is now centered about the 'behavioristic' movement, which, with its gospel of objective methods and its crusade against introspection, presents an interesting blend of solid contribution and adolescent exaggeration. Whatever seems to me to be sound in its position, I have adopted. It lends itself readily to incorporation into the biological conception of mental activity, which I have retained and energetically pressed.

The *organizing* character of every level of our psychomotor activities is more explicitly brought out than in the older book, with advantage, I trust, to the depth and vividness of impression left on the reader's mind regarding the real nature of our adjustments to environment.

I have come in recent years to assign more importance than I formerly did to the function of subconscious processes in our behavior. I do not for a moment accept the prurient implications of much of the Freudian doctrine, nor have I been greatly influenced by any of its contentions; but on other grounds I have come to the belief that there is a large element of intrinsically intelligent control in many neural processes which escape our direct conscious observation. This I hold to be as true of reflective thought as of the more overt control of our muscles. The text will be found to reflect something of this conviction.

My views on the function of imagery have been a good deal misunderstood. This is hardly the place in which to confront my critics, but I trust that the present text may be found less open to misapprehension. With the recently developed doctrine of 'imageless thought' I am warmly sympathetic so far as it has served to direct attention to the *meaning* aspect of our mental operations, in distinction from their mere sensuous texture. Much of its pretense to novelty I think is based on the misconstruction of earlier doctrine. Its postulate of the existence of states of consciousness wholly devoid of sensorial or imaginal factors I regard as altogether unsubstantiated.

After extended conferences with teachers I have decided to omit any practical exercises. In the first place I find that many instructors prefer to prepare their own; and in the second place there are now a number of admirable manuals written to supply this precise need. I consider such exercises an essentially indispensable part of a well-rounded introductory course, but they need not be made dependent on the teachings of any particular text.

For the use of a number of illustrations acknowledgments are due to the following authors and publishers: D. Appleton & Co., publishers of Barker's "The Nervous System"; Ginn & Co., publishers of "The Elements of Physiology" by T. Hough and W. T. Sedgwick; John Murray, publisher of "The Physiology of the Sense Organs" by McKendrick and Snodgrass; G. P. Putnam's Sons, publishers of Loeb's "Physiology of the Brain"; W. B. Saunders & Co., publishers of Howell's "Text-Book of Physiology"; and Walter Scott, Ltd., publishers of Donaldson's "Growth of the Brain."

I am under many obligations to my former students and to my colleagues at the University of Chicago for suggestions and criticism. My wife has aided me greatly in the preparation of my manuscript.

J. R. A.

CHICAGO,
May 1, 1918.

PREFACE TO SECOND EDITION

The present edition contains only minor alterations designed to add useful material at a few points in the text, or to avoid certain infelicities of expression to which attention has been called.

J. R. A.

April 1, 1919.

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AN INTRODUCTION TO PSYCHOLOGY

CHAPTER I

PROBLEMS AND METHODS OF PSYCHOLOGY

The Subject Matter of Psychology.—Old and well established sciences generally feel it unnecessary to define themselves for the benefit of the beginner. Young sciences, on the other hand, commonly seek to make clear the field which they propose to occupy. To the beginner, any definition of a science must be somewhat vague and formal, because he cannot intelligently interpret its real meaning in advance of a knowledge of the facts with which the science deals. We shall therefore make no serious effort at this point to construct a precise definition of psychology, which is the youngest of the biological sciences. It is, however, possible to give rough indications of a helpful kind regarding the general character of the problems to be confronted.

The older definitions of psychology spoke of it as 'the science of the soul,' and this designation was long employed and only abandoned at last because of the many confusing implications of the word *soul*. Then followed a period when psychology was described as 'the science of mind.' In its turn the word *mind* in this definition was abandoned in favor of the term 'consciousness.' In each case a more general and less compromising term was substituted for one about which there had gathered a group

of irrelevant or misleading associations. Consciousness itself has now fallen victim to the same movement, and in its place we are urged to use such terms as 'behavior,' 'conduct,' or 'intelligence.'

At this juncture it is far less important to secure a verbally precise and accurate definition than it is to gain a fruitful working idea of the general range of facts with which psychology deals, and the technique by which it gathers, organizes, and interprets these facts. Broadly speaking, then, the psychologist's subject matter concerns thinking, feeling, and acting. When psychology is defined, as often occurs today, as the *science of behavior,* it is to be understood that the term behavior includes these three processes.[1] We shall try in this book to point out what are the materials of which intelligence is composed, what the conditions under which it arises, what the purposes for which it is employed, and what the manner in which conduct is controlled. The attempt to unravel all the strands which are twisted together in this skein of life will take us into the study of many facts seemingly remote from those which we thus set out to explore.

Physiological and Social Conditions of Human Experience.—In the first place, all life is built upon physical and physiological foundations. It is quite impossible to understand human nature, even in a common-sense way, without a knowledge of the bodily structure of the human being. Much less can one pretend to scientific knowledge without recourse to physiological materials. We shall therefore find it frequently necessary to employ informa-

[1] A few advocates of 'objective psychology' or 'pure behaviorism' would wholly disregard thinking and feeling, devoting their entire attention to a study of motor activity.

tion about the body, and particularly about the brain and nervous system.

Again, all life to some extent, and especially human life, is lived among social surroundings. It is idle to attempt to understand human behavior without constant regard to these social relations. Our modern science has taught us to see all contemporary conditions in the light of their evolution from the past. These social conditions quite as truly as those of a physiological kind are today interpreted from the point of view of development and adjustment. Life has always been a process of adapting the organism to the physical conditions of climate and food supply on the one hand, and to social organization on the other. The conduct of man today reflects the race-long history of struggle and adjustment in each of these directions, and to understand any piece of behavior involves taking into account to some extent influences which point backward to this illimitable racial past.

Methods of Gathering Facts in Psychology.—There is in progress at present a very vigorous controversy as to the correct method in psychology. The traditional one upon which all the early accomplishments of psychology rest is known as introspection. It consists in the direct systematic process of self-observation. I ask myself to recall what I was doing yesterday at this hour, and immediately after bringing into mind the events in question, I try to discern and describe the particular manner in which the occurrences are portrayed in my thought. I may, for example, in my 'mind's eye' see myself walking to my office. Evidently such a method is at the disposal of anyone who chooses to employ it. It is purely observational, differing from the usual forms of *external* observa-

tion in having one's own *internal* mental operations as its object, rather than the facts and events of the outside world.

A good deal of mystery has at times been attached to this introspective process, and unmeasured criticism has been directed at it, ranging all the way from a denial of its possibility on the ground that a mental state cannot observe itself while it is going on, down to the less sweeping but more pertinent criticism, that the method is prone to many forms of error which are extremely difficult to control. The merits of this controversy can hardly be entered upon here. Suffice it to say that direct observation of the kind described, i.e., of mental experiences just past, is a commonplace of everyday life, and that, carried out carefully and systematically by many individuals, it has resulted in the accumulation of a very respectable body of knowledge entirely worthy of the term scientific.

Over against introspection or subjective observation, is the general method of objective observation, which is essentially that employed in all the physical sciences. The defenders of the latter urge that it is the only really scientific method, because it is the only one affording unequivocal opportunity for verification of alleged facts and events by more than one observer. Needless to say, chemistry, physics, geology, and the biological sciences in general are based entirely upon this method. As applied to psychology, it necessarily involves the attempt to use the external bodily expressions (e.g., gestures, words, facial movements, etc.) as a basis for the understanding of behavior, and its advocates maintain that one can accurately describe and measure the significant facts of mental activity just in the degree in which one can determine its

external manifestations. All else, they say, is elusive, and purely subjective and incapable of scientific treatment.

The fact that mental states do ultimately secure expression in conduct need not be questioned; nor is anyone likely to doubt that many states of mind, such for example as anger or embarrassment, may be reflected immediately and unequivocally in facial expression. But there is also no reason to call in question the fact that at present, at least, our ability to detect accurately the external expressions of the great majority of our mental states lags far behind our ability introspectively to describe and analyze them. Who can say from observing my external appearance whether I am thinking about Napoleon or Julius Caesar? It seems, therefore, to be the part of common sense to avoid the extremism of the partisans in this controversy. Let us recognize that wherever possible, it is highly desirable to make use of the bodily expressions of mental states, because of their tangible objective character; but wherever this is impossible, as is at present the case in many regions of mental life, let us rely upon trained scientific introspection.

Scientific Organization of Data.—It should be clearly understood that both of these methods to which reference has just been made have to do with the gathering of data, the collecting of the facts of intelligent behavior. This process is the first step in any science, but it is only the first. There then remains the task of analyzing and organizing the facts, of classifying them in ways which will exhibit their relations to one another and make them intelligible in their entirety. Moreover, wherever this is practicable, a modern science, in addition to trying thus to analyze and describe, attempts to explain. Analysis, or-

ganization, explanation, the ability to predict events because of the knowledge of the relations of cause and effect in a given group of phenomena—these are the characteristics of every established natural science.

Experiment in Psychology.—Quite the most important modern advance in psychology is to be connected with the development, in the middle of the last century, of the experimental movement. Progress in the other natural sciences has been rapid directly in proportion to their development of experimental technique. An experiment is an observation made under conditions of control. It gains its crucial importance from the fact that it permits an *exact* repetition of conditions, and thus makes possible verification by many observers of whatever facts are reported. It had always been supposed that mind was excluded from experimental attack because the necessary control could not be secured. Thanks largely to the work of Weber, Fechner, and Wundt, the possibility of psychological experiment has been forever put beyond the pale of doubt. While some mental processes are more resistant than others to experimental approach, there is hardly any significant group of mental operations which has been found entirely obdurate. By far the greater portion of our mental life has been already to some extent explored by experimental methods.

Experiment has shown itself fruitful both in the range of introspection and in that of objective observation. In the one case, the experimental situation is so devised as to assist introspective analysis, and to permit the reinstatement time after time of substantially the same mental conditions. After-images of color may thus be studied by repeating the stimulus again and again. In the case

of direct observation, the experiment is designed to elicit modes of behavior which can be observed and recorded by the experimenter. The promptness of a movement made in response to a sound, for example, can thus be determined by time-measuring apparatus. Although both types of observation are thus involved in experimental procedure, it is probably fair to say that the objective type is tending on the whole to displace the other.

The Different Fields of Psychology.—In the present text we shall be chiefly concerned with the facts involved in ordinary human behavior. This field is commonly designated *general psychology*. It has to do with the typical forms of behavior characterizing the normal adult. There are, however, other important divisions of psychology which we shall invade from time to time in order to secure useful material. The mental life of children has been rather extensively studied, and constitutes a reasonably distinct branch of investigation, sometimes called *child psychology*, sometimes *genetic psychology*. Similarly the study of mental abnormalities constitutes another subdivision generally spoken of as *abnormal psychology*. Despite the fact that all mental life of human beings is lived amid social surroundings, and that it is quite impossible to understand human behavior without regard to influences which arise from these relations, it has been found profitable to create a special division known as *social psychology*. In this field attention is particularly directed to a study of the explicitly social instincts and attributes of the mind, and to an analysis of the mental factors in social organizations and institutions. *Race psychology* is an older division of the subject, devoted to the attempt to ascertain and describe those peculiarities of

temperament and behavior which ostensibly characterize different races. *Variational psychology,* or *individual psychology,* concerns itself with the study of those personal idiosyncrasies of temperament, taste, intellectual capacity, etc., which mark off one human being from another. Much of the most interesting and significant addition to our psychological knowledge has in recent years come from the study of animal behavior. To this field is generally applied the term *animal psychology,* or sometimes the term *comparative psychology.*

There is a branch of psychology known as *physiological psychology* which has historically grown up side by side with experiment, and made incessant use of experimental procedure. Strictly speaking, it ought perhaps to be regarded as a special psychological field. It is often spoken of as though it were a definite method. However it may be classified, it consists as a matter of fact simply in the attempt systematically to study mental life in connection with bodily processes, particularly those of the brain and nervous system. We shall have frequent occasion to make use of its materials.

Psychophysics is a name applied to a branch of psychology developed by the German scientist, Fechner. It has led to the development of *quantitative psychology,* which is concerned with the attempt to measure mental processes. We shall have relatively little to do with this division of psychological inquiry.

Psychology and Other Sciences.—In advance of any detailed knowledge of psychology, it is hardly profitable to dwell upon its relations to other natural sciences. Suffice it to say that like them, it has historically developed out of philosophy, with which it still retains rather more

intimate relations than do those sciences, e.g., physics and chemistry, which separated themselves from the parent (philosophical) stem at an earlier time. As a science psychology may fairly claim a place in the biological group, because its subject matter is life in certain of its expressions. The intimacy of the relationship is in a measure attested by the extent to which psychology conceives of its problems in evolutionary terms and in terms of the adjustment of the organism to physical and social environment.

Like other sciences, psychology has both a pure and an applied aspect. In its applications, it stands closely related to education, to medicine, to jurisprudence, and to many of the professional and practical interests of life. These applications are still in their early infancy, and, although extremely interesting and valuable, must presumably wait for any approach to completeness upon a far higher development of the pure science. It is fair to add that they are themselves making genuine and important contributions to this pure science.

CHAPTER II

INHERITED AND ACQUIRED BEHAVIOR

It will perhaps assist us if, before proceeding to a detailed study of behavior, we pass rapidly in review some of its chief forms. This will give us a rough working idea of the path which we are to follow in our more exact analysis.

Classification of the Forms of Behavior.—For practical purposes we classify behavior in many different ways. We speak of it as good or bad, as kind or cruel, as thoughtful, stupid, or clever. Evidently such divisions are designed to mark certain moral or intellectual qualities which we think of as attaching to it. Again, we may classify from the point of view of the special kind of action involved, e.g., work or play. Walking, speaking, writing, skating, golfing, playing the piano, are all modes of behavior which might be thus distinguished.

For our present purposes the most useful classification and the one which we should keep constantly in view, will be that which distinguishes *innate, inherited,* and *instinctive* forms of behavior from those which are *acquired,* and we may profitably proceed to a brief description of these two types.

Instinctive forms of action are such as the nest-building activities of birds and insects, the seasonal migrations of fishes, birds, and certain mammals, the homing habits of pigeons and certain marine birds. All these forms of

behavior have in common this native inborn character and their fitness to achieve certain ends necessary to the preservation of the animal or the species. However much an animal may be influenced by the example set by others of its kind, it is quite capable of executing these instinctive acts wholly without tuition. In this sense they are entirely native, and not learned.

Although popular conception does not always recognize this fact, it is nevertheless true that man himself possesses many of these innate forms of behavior. The trembling of the limbs, the blanching of the face, the dryness of the mouth, the nausea and faintness of terror, are instinctive modes of behavior, natural to every child and carried out quite without regard to either precept or example. Similarly the clenching of the fist in anger, the flushing of the skin in embarrassment, the shedding of tears in sorrow or in rage, are all indigenous modes of behavior, inborn in every human being. These activities, like those cited from animal behavior, are all designed to secure some end essential to the welfare of the individual or the race.

Some of the expressions of this character called reflex acts are very simple and are called forth by relatively simple situations. For example, the contraction of the iris in the presence of strong light is a relatively simple muscular movement made in response to the single stimulus, light. The act of coughing is similarly a rather simple muscular response to irritation in the throat. Evidently the incentive to the instinctive response in embarrassment is somewhat more complex. It involves the apprehension of an entire situation, instead of the mere sensing of a single stimulation like light or irritation of the membranes of the throat. There is a very large group

of these innate forms of behavior of which ordinarily we are wholly unconscious. All the great life-sustaining bodily operations are of this character. The beating of the heart goes on for the most part entirely without attracting our notice. The normal processes of digestion are similarly unconscious. Even our breathing rarely intrudes itself upon attention.

It is clear, then, upon the most cursory observation, that the human being comes into the world already provided with an amazing number of muscular capacities at his disposal. The maintenance of life is from the very first dependent upon the proper operation of these inherited activities. As we shall later see, these instinctive traits constitute the foundation upon which are erected all the acquired modes of behavior which we shall presently study.

Acquired Behavior.—As was suggested in the last sentence, the acquired forms of behavior rest upon the instinctive types, but they nevertheless represent quite a different order of affairs. Nobody is born with the ability forthwith to play the violin or to use the typewriter. Both achievements require long practice and painstaking effort. Speech and walking both have an instinctive basis, to be sure, but both require an extended period of learning before they are at all perfect or complete. Practically all our dexterities and acts of skill are of this character. The putting on and off of our clothing, the manipulation of the common utensils of daily life, our social deportment—expressive of the conventional etiquette of our own time, civilization, and set—our enunciation, our professional habits, even in large measure our moral and religious practices and beliefs, are of this acquired character.

As we shall discover at a later point with more detail,

these acquired acts have all become established as the result of processes in which the mind has played a decidedly conspicuous part. In this regard they are essentially different from the instinctive modes of behavior. Of these latter we may indeed be aware, but they do not owe their peculiar form to any thought which we have accorded them. As they were born in us, so they appear. Obviously the execution of the elaborate conventional social forms peculiar to every civilization involves careful tutelage and a distinct conscious effort of acquirement. The gestures proper to the greeting of a lady by a gentleman in Western Europe are not to be learned without studious effort. Similarly the behavior appropriate to the participant in a ritualistic service involves a prolonged apprenticeship before it can be successfully mastered.

Acquired Acts Become Automatic.—All these illustrations suggest what is a fundamental truth later to be more fully explored, i.e., that many acts which require in their early stages alert conscious supervision, become after a time essentially automatic and take care of themselves; that is to say, they tend to simulate the instinctive and innate forms of behavior. As a child, it requires a long and tedious course of training to master the niceties of table etiquette. But once this is thoroughly learned, it practically cares for itself; and the same thing is true of all the other acquired types of behavior. It is surprising to find how large a part of the behavior of one's working day is of this automatized, habitual kind, and how little of it involves immediate, thoughtful supervision. This is but another way of saying that we are creatures of routine. It involves, however, explicit emphasis upon the fact often

unappreciated, to-wit, that well-established routine demands very little active mental control.

Instinctive Behavior in Animals.—As we have already intimated, the modern evolutionary conception teaches that those types of reaction which are effective in maintaining the life of the species inevitably tend to become fixed and to be perpetuated. Nature, it is said, cares nothing for the individual, but everything for the species, and while this is no doubt an overstatement of the truth, there are instances, particularly in insect forms, where the individual sacrifices its life in the act which creates the new generation. It is certainly true, however, that no mode of behavior can hope for survival which stands opposed to the successful maintenance of the species. The great body, then, of instinctive forms of behavior represents types of reaction which have been found useful in the past for the preservation of the species. Many of these, in the nature of the case, must make for the safeguarding of the individual as well. But as we pass upward in our survey of the animal forms from the lower to the higher, we find increasing opportunities for individualistic types of adjustment, and it is in this region of adaptive behavior that we encounter the group of actions which we have called acquired. They, too, are broadly preservative in character, but they represent the region of unstable and incomplete adjustment. The individual tries out for himself a new line of action, which may prove a success or a failure.

The simplest type of the known animals is represented by amoeba. The amoeba is an almost structureless speck of jelly-like protoplasm. Under the microscope it can be seen to consist of a nucleus surrounded by fluid protoplasm. This little organism secures its food by gradually envelop-

ing it with its liquid surfaces. If it be attacked by strong acids, or similar stimuli, the protoplasm tends to flow away from the source of attack. Its reactions are therefore confined to these simple activities of approach and retreat, with the assimilation of food and the rejection of waste products, all functions of this one simple cell-like structure. Evidently the scope of adjustive activities for such a creature is extremely limited.

Passing to a much higher order of animal life, such as is represented by the fishes, we find again that the main forms of adaptive behavior have to do (1) with the securing of food; (2) with the escape from harmful objects, including both animal enemies and unfavorable physical surroundings, e.g., water which is too cold, too salt, etc.; and (3) with the propagation of the species. In the amoeba, this latter function is brought about by a mere division of the parent cell. In addition to the commoner modes of instinctive expression in connection with the functions which we have listed, fishes, and particularly birds, display the most amazing migratory adjustments, designed to afford them favorable surroundings for the several stages of their life cycle. Practically all our common birds migrate annually over considerable ranges of territory, and some of them journey from the northern end of North America to the extreme southern end of South America.

To adjusting activities of the kinds described, the more intelligent mammals (to say nothing of the fishes and birds) add many types of gregarious instincts, which often safeguard the members of the group from their common enemies. In some cases this community action has an aggressive rather than a merely protective char-

acter. Wolves, for example, hunt in packs, as do some other forms of wild animals. Buffalo, deer, and domestic cattle live by preference in herds whose numbers to some extent protect them from the assaults of their enemies. In such group association they benefit by the leadership of the stronger and more intelligent members of the herd.

Modification of Instinct in Man.—There is perhaps no single one of these protective forms of animal behavior which does not find a substantial counterpart in the behavior of man. But in almost every case a form of behavior, which in the animals is primarily instinctive, is in man modified through various kinds of acquired adjustments and often perfected to a degree quite surpassing the animal form. Against the rigors of the winter the bear retires to his den in a cave, the squirrel to his nest in the tree, but man builds for himself the most elaborate of artificial shelters. Where the bird migrates from one end of the continent to the other in search of equable climate, man so devises his house that it may be cool in summer and warm in winter. In other words, he artificially creates his own preferred climate. The animal in his search for a livelihood may be carried by conditions of climate over many degrees of latitude. Man, by his control over agriculture and husbandry, assures himself adequate food at his very door the year around.

More striking still than his mastery of those forms of adjustment which relate to climate, food supply, and the general characteristics of physical nature, is the extent to which his instincts have been evolved to meet social conditions, and the skill with which of his own intelligence he has learned to adapt himself to the demands of social circumstance. If one disregard the appetites of

hunger and thirst and the instincts connected with their satisfaction, one may say that practically all the remaining human instincts are either dominantly or exclusively social in their import. Anger, hate, fear, love, sorrow, sympathy —the list may be drawn out almost indefinitely—all point to social forms of adjustment. Arising primarily out of the great group of instinctive impulses, but with modifications introduced at various points by reflective intelligence, man has evolved those great social institutions which we designate religion, law, custom, government and the state, the family and the church. Even commerce and industry, and agriculture in all its forms, represent concretely the modes in which man has developed his processes of adjustment to nature and to his fellow-man.

These illustrations may serve to suggest how wide is the range in animal and human life over which is distributed the process of adjustment, and how manifold are the forms with which it clothes itself. It remains only to point out that while much of this adaptive process is carried out by instinctive and often unconscious inherited activities, a large part of it is the result of the play of thought and feeling flowing out into acts of will, constituting in their entirety what we commonly call the life of mind. Our study in this book will be devoted to both these factors in behavior, i.e.; instinctive and acquired characteristics, but more particularly to the last named portion of them.

CHAPTER III

THE NERVOUS SYSTEM

In the preceding chapter, attention was directed to certain of the broad typical forms of organic adjustment to environment. In the animal kingdom as a whole probably the great majority of these acts are reflex in character and involve little or no direct mental supervision. In man, however, the types of adjustment which are of most significance are those which involve the definite use of the mind. Human interest is naturally centered in the things which we choose to do, or not to do; the things which provoke our strong feeling, which challenge our courage or intelligence, which stimulate our ingenuity and test our perseverance.

To even a superficial survey of the situation it must be evident that the mind comes into possession of its knowledge through the use of the *bodily senses,* and that in turn it makes itself effective through its control of the *bodily muscles.* Without the body the mind, as we know it, would obviously be rather helpless. Modern psychology has therefore been disposed to learn all it could regarding those portions of our physical structure which are important for our mental life. Pursuant to this tendency we shall now undertake to gain a rough working conception of the nervous system, which more than any other part of our bodily frame is responsible for the peculiarities of mental behavior. We shall make no pretense of entering

in any detailed way upon the anatomy or physiology of the nervous system. We shall, however, attempt to secure impressions, which, so far as they go, will be accurate and of a kind to render us constant assistance in the course of our study.

FIG. 1.—Diagram of an amoeba greatly magnified. The irregularly shaped mass of protoplasm is shown with *N*, its nucleus, and *CV*, a contractile vacuole, which expands and contracts.

The biologists tell us that the earliest forms of life were marine plants and animals, presumably of the simplest possible structure, like the amoeba (Fig. 1) to which reference was made in a previous chapter. In animals of this type, every part of the body appears to be sensitive to stimulation. Every part appears capable of moving. There is no definite specialization of function. But as we pass to higher forms, we early meet with the beginnings of that process which in the higher animals has resulted in the differentiation of functions among tissues. To some are assigned digestive functions, to others respiratory functions, while to the nerves falls the function of transmitting excitement from one part of the organism to another. These last mentioned tissues have appropriated to themselves the functions of control which accounts for their special claim upon our attention. Figures 2 and 3 exhibit simple forms of nervous systems.

Main Subdivisions of the Nervous System.—There are

two great subdivisions of the nerves which share between them the important duties to be performed. One, the so-called 'central' system cares for the adjustment of the

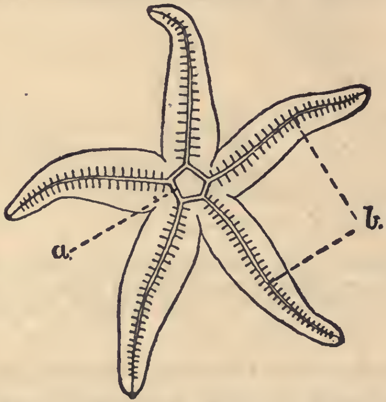


FIG. 2.—Nervous system of a starfish; *a*, central nerve ring that surrounds the mouth; *b*, peripheral nerves of the arms. (After Loeb.)

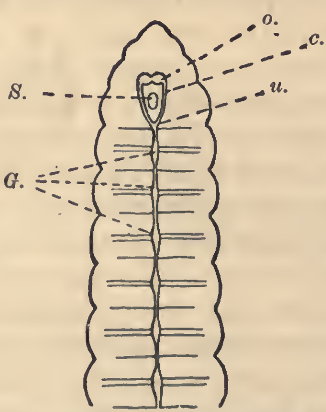


FIG. 3.—Dorsal view of the central system of an earthworm; *o*, supraœsophageal ganglion; *c*, commissure; *u*, subœsophageal ganglion; *S*, pharynx; *G*, ganglion of the ventral cord. (After Loeb.)

organism to the outside physical world. The other, the 'autonomic' system, more often known as the sympathetic system, provides for the proper functioning of the bodily organs themselves. The central system connected through one set of terminals with the various sense organs such as the eyes and the ears, and through a second set with the muscles, enables the organism to move about successfully in search of food and shelter and in avoidance of danger. Meantime, the autonomic system keeps the digestion, respiration, and circulation in order, oversees many of the reflexes and more particularly the processes of assimilation and excretion, and in general assures conditions of physical life and health. The central system may be thought of as the provider, the autonomic system as the housekeeper. Of course their functions somewhat overlap, for the two are intimately connected, and neither one could get on without the other. Mental life is in some ways more immediately connected with the activity of the central system, as we shall presently see, but it is also related to the autonomic system in many important particulars.

Although the differences in these two great divisions of the nervous system are sufficient to make it wise to consider them separately, both are made up of elementary structures known as *neurones* which we must briefly describe.

The Neurone, the Element of the Nervous System.—The fully developed neurone resembles roughly a very slender thread with a knot near one end of it, the end beyond the knot being frequently frayed out into a number of brush-like endings. (See Fig. 4.) The part of the neurone corresponding to the knot is the so-called cell body, which corresponds roughly to the seed out of which a plant develops. It is the vital center of the neurone,

and if it be destroyed, the remainder of the structure will die. Like the plant seed, which gives off certain fibers that develop into the root and others which become the

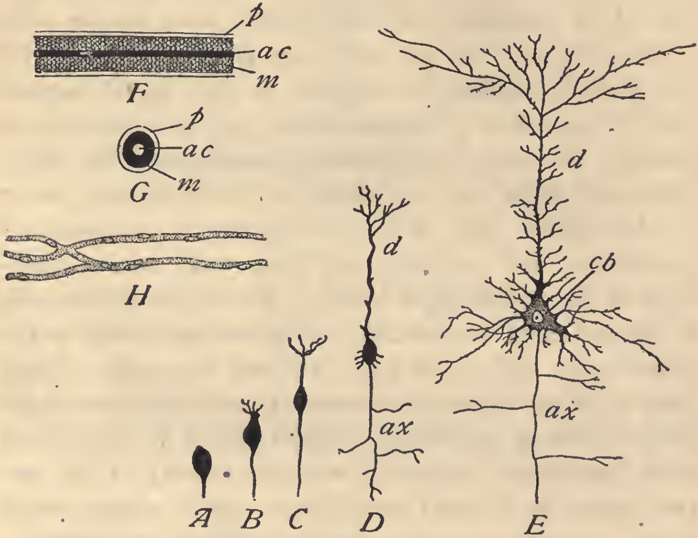


Fig. 4.

A, *B*, *C*, *D* represent successive stages in the development of a young neurone. *E* represents a fully developed pyramidal cell from the cortex of the cerebrum, showing the granular and nuclear character of the cell body. *D* and *E* both show the differences in the appearance of axones, *ax*, and dendrites, *d*, and *F* exhibits the typical structure of a fully developed nerve fiber of the periphery. *ac*, the axis cylinder, or true nerve, of the axone; *m*, the thick pulpy medullary sheath; *p*, the thin membranous primitive sheath, both the sheaths protective and probably nutritive; *G*, shows a cross-section of such a nerve trunk. *H* exhibits segments of the unmedullated fibers of the sympathetic system. (Modified from Cajal and Toldt.)

stalk, the cell body of the neurone usually gives off two forms of minute filaments. These possess as a rule certain differences in appearance shown in Fig. 4D, E. The neurones

vary enormously in their dimensions. Some of them may be two or more feet in length. Such are the fibers which extend from the base of the spinal cord into the sole of the foot. Others (examples occur in the brain) are only a fraction of a millimeter in length, and a cross-section of any of them short or long would ordinarily require a microscope to be clearly seen. The nerves which are sometimes exposed to view as the result of an injury or an operation are in reality great bundles of these little fibrils, brought together like the wires of a telephone circuit in a cable, such as one may often see upon our streets.

Classification of Neurones.—For our purposes the neurones may conveniently be divided into three great groups: (1) those which carry impulses in toward the central system. These are called sensory neurones or receptors, because they receive sensory stimulations. (2) The neurones which carry impulses from the central system out to the muscles or glands. These may be called effectors, because they produce specific effects of adjustment. Effectors entering muscles are frequently designated motor nerves. (3) Those which connect the first group with the second. These may be called central adjustors, or connectors. Although the forms of the neurones differ somewhat when seen under the microscope, according to the particular portion of the nervous system from which they come, they are alike in the fact that, so far as is known in the higher organisms at least, normal nervous impulses always flow over them in one and only one direction. This means that a neurone which customarily conveys impulses from a sense organ to the brain or cord can never conduct an impulse backward from

the cord or brain to the sense organ. Similarly the effector, which carries impulses out toward the muscles, can never convey an impulse back from the muscle to the center. We may express the situation in magnetic terms by saying that the nervous system is polarized. Its currents flow only in one direction.

Each sensory receptor terminates at or beneath the surface of the body in contact with some kind of specialized tissue so organized as to be sensitive to a particular form of physical or chemical stimulus. Thus the optic fibers terminate in contact with the rods and cones of the retina, of which we shall learn more in a later chapter. These microscopic structures are sensitive to light. When they are stimulated, changes occur in them (probably of electro-chemical character) that set up impulses in the nerve fibers, which then transmit the nervous excitation to the brain. The auditory neurones terminate similarly in the internal ear, about the bases of minute structures known as hair cells, which are thrown into vibration when sounds fall upon the ear. Again, the nerves distributed to the skin come to an end in contact with minute structures in the dermis, which are sensitive to contact, or to heat, or to cold. One form of cutaneous neurone, i.e., the so-called "pain nerve" has not thus far been found to have any special terminal organ. But this is an exception to which we shall return in another chapter.

Certain effectors or motor nerves leading out from the central system terminate in the surfaces of the muscles. When a nervous impulse travels down one of these nerves, it causes the muscle with which it is connected to contract, and this in turn brings about a movement of the part of the body in which the muscle is found. When the

reader raises his hand to turn the page of this book, the movement is brought about by just such a nervous impulse originating in the brain and passing from that point through the spinal cord and over motor nerves into the muscles of the hand and arm. Similarly, an impulse may

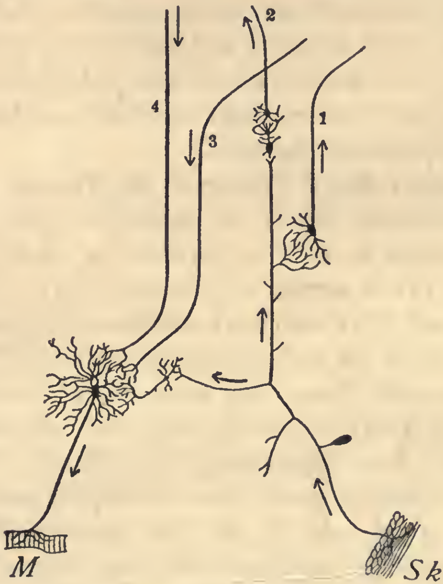


FIG. 5.—Diagram to illustrate synapsis of arborization of axone of a sensory receptor from the skin, *SK*, with dendritic terminals of central system neurones, 1, 2. The synapses of motor axones, 3, 4, with dendrites of an effector terminating in a muscle, *M*, are similarly shown.

be sent out into a gland, which is then thrown into activity, whether of secretion or excretion. A cinder in the eye will thus occasion a flow of tears. As we shall see in more detail at a later point, certain of the glands are excited to great activity by the more powerful emotions.

The central adjustor neurones are located within the great

masses of the spinal cord and the brain, and we shall give a brief description of them presently.

Neurones come into connection with one another at the terminal points of their fibers as shown in Fig. 5. Whether they actually touch or not is unknown. At all events they are very close to one another. Such junction points are called *synapses* and are of very great importance in the operation of the nerves. Like the nerve fibers themselves, they are seemingly polarized, so that impulses can pass in only one direction.

The Sensory-Motor Pattern of the Nervous System.—The fundamental pattern in accordance with which the nervous system is built up involves, as we have already indicated, (1) a system of receptors, (2) a system of effectors, and (3) a system of interconnecting neurones by means of which the various muscles are brought into communication with the various sense organs, so that (4) a stimulation of any one of the latter may occasion a movement of any one of the former. (See Fig. 6B, C.) In the lower types of organism, these connections are relatively fixed and rigid, and in the first instance the muscles are innervated by impulses which arise from sense organs lying in the same region of the body. This arrangement is represented diagrammatically in the accompanying sketch. (Fig. 6A.) The use of such an arc, or circuit, as it is called, would be illustrated by the reflex withdrawal of the hand when it is cut or bruised or burned. In such a case the nervous impulse passes up the receptors into the spinal cord, where it is turned about and sent over the effectors into the muscles of the hand and arm.

The brain and the cord in their entirety represent very elaborate complications of this basic pattern, of such a

kind as to permit almost every conceivable combination of relations between sense organs and muscles. The hand may be moved not only in response to stimulations from the skin of its own surfaces, but also in response to stimu-

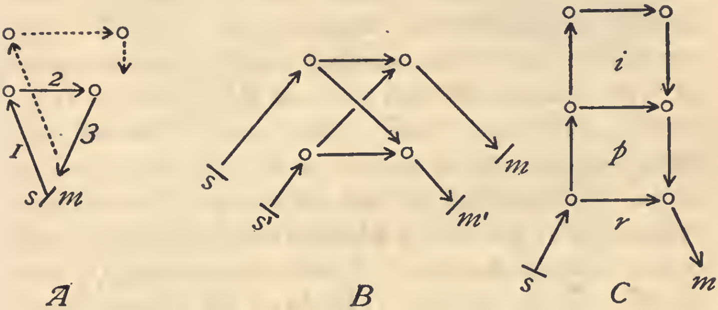


FIG. 6.

A exhibits pattern of the simplest sensory-motor arc, where a peripheral stimulus immediately elicits a movement of the region stimulated; 1 is the receptor, 2 the connector and 3 the effector. In some very simple reflexes 1 may be directly conjoined with 3, omitting 2. The diagram also suggests in the dotted line a very important fact, *i.e.*, that the contraction of *M* sets up kinæsthetic sensory impulses which pass into the nervous centers, opening a new circuit, and in turn, perhaps, eliciting other movements.

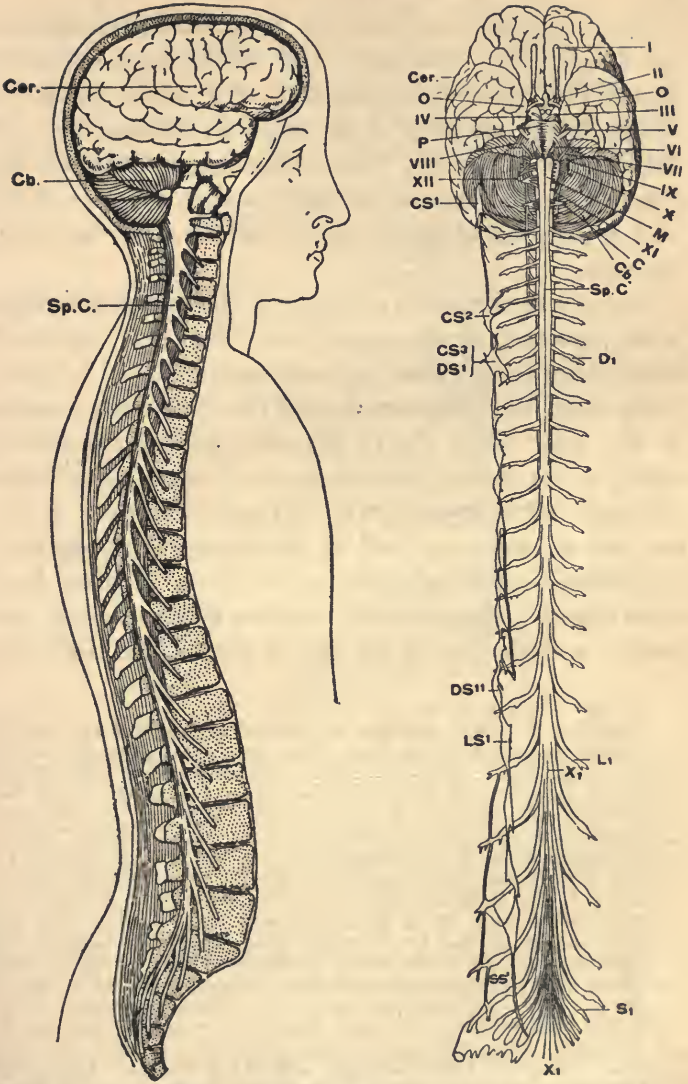
B illustrates how two sets of muscles may be innervated from either of two sets of sense organs. The same pattern can be elaborated to include all the senses and all the muscles. It is purely diagrammatic. The actual paths would involve many more neurones.

C illustrates rudely three levels of circuits in the nervous system. The lowest, *r*, is purely reflex and does not necessarily involve consciousness. It is typified by the conditions in the spinal cord, medulla, and lower brain centers. These neurone circuits are congenitally open. The second, *p*, represents the level of crude perceptual reactions and mere sensory-motor learning, such as most animals exhibit. The sensory-motor regions of the cerebrum are presumably represented in these circuits. The ideational circuits are represented by *i* and involve conscious memory, imagination, reflective thought and rational inference. In addition to the sensory-motor zones, this circuit makes use of the most highly developed regions of the cerebral cortex, *i.e.*, the frontal, parietal and other association areas. See the later part of this chapter.

lations from other cutaneous regions, as when one lifts the right hand to remove some object pressing upon the left hand, or some other body surface. Similarly, it may be moved in response to a sound which is heard, or an object seen, etc. As we have already observed, many of these muscular movements are inherited, and are, upon the appropriate stimulation, executed without previous training. The simplest of such acts are called reflexes (e.g., coughing, sneezing, crying). Many others, however, and among them the acts of most psychological interest, are in part or wholly acquired, that is, learned. The flexible organization of the central adjustor neurones renders such learning possible, because it permits the conjoining of any receptor with any effector. If the hand, for example, could not be controlled by stimulations from the eye but only by those from the skin, it would be extremely difficult to learn to write, or to use the typewriter, or to perform any of the other acts of skill in which the hand is largely directed by vision. Moreover, in man—in contrast to the conditions found in many animals—arrangements exist for the control of the muscles from ideational, as well as from sensorial, centers.

If the reader will bear constantly in mind this notion of the central nervous system as made up of elaborate combinations of sensory and motor elements, it will be found to throw light upon the general anatomical situation, which we may now attempt to describe in a little more detail.

Main Divisions of the Central System.—The *central nervous system* comprises the brain, the spinal cord, and the two great groups of receptor and effector neurones. (See Figs. 7 and 8.) The brain and cord are nothing but masses of neurones gathered together and held in place partly



FIGS. 7 and 8.—Fig. 7 at the left shows the general relations of the central nervous system to the bones of the skull and spine.

by the veins and arteries, partly by a connective supporting tissue called neuroglia, and partly by a series of strong, firm membranes enclosing these great masses as though within the walls of an irregularly shaped bag. In the case of the brain, these containing membranes are attached to the bones of the skull, and in the case of the cord are supported within the central canal of the spinal vertebrae.

Figure 9 illustrates in a rude way the essential features in the structure of the spinal cord. The outer regions of the cord near its surfaces are exclusively occupied by nerve *fibers* which carry impulses to and fro. The inner regions, on the other hand, are largely composed of *cell bodies*, which, as we earlier learned, are the centers from which the nerve fibers spring. The two great functions of the cord are at once suggested by its anatomical appearance. It is first a great reflex center, receiving impulses from sense organs, and immediately sending them out again into muscles and glands. If the sole of the foot be tickled or

Fig. 8 at the right displays the general contours of the central system as seen from in front. The great ganglionated cord of the sympathetic system is shown attached to one side of the spinal nerves; the other side has been cut away. *Cer.*, the cerebral hemispheres; *O*, the olfactory centers; *P*, the pons Varolii; *M*, the medulla oblongata; *Cb.*, the cerebellum; *Sp. C.*, the spinal cord; *I*, the olfactory nerve; *II*, the optic nerve; *III*, the oculo-motor nerve, connected like *IV*, the trochlear nerve and *VI*, the abducens nerve, with the muscles of the eye; *V*, trigeminus, made up in part of sensory fibers coming from the face and scalp, partly of motor fibers supplying neighboring regions; *VII*, the facial nerve, similarly in part giving sensory fibers to the face, tongue and neck, in part made up of motor fibers; *VIII*, the auditory nerve; *IX*, glossopharyngeal nerve, giving both sensory and motor fibers to throat and tongue; *X*, the vagus nerve, both sensory and motor, very complex distribution, chiefly to heart, stomach and other viscera; *XI*, spinal accessory, connected with sympathetic system; *XII*, hypoglossal nerve, motor fibers to tongue.

pricked, there is at once a reflex jerk of the foot for which the spinal cord is responsible; and this is typical of other forms of reflex action under the control of the cord. In the second place, it is the great channel through which impulses from many receptors flow upward into the brain,

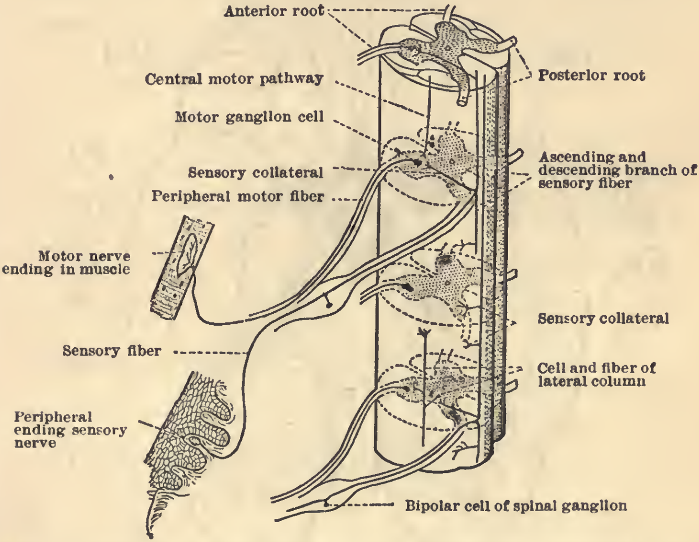


FIG. 9.—Schematic representation of the connection of sensory and motor nerves with the spinal cord, and their synapses with one another inside the gray matter of the cord. The cross section at the top of the diagram exhibits clearly the difference between the white marginal fibrous material and the H-shaped center of gray cellular matter. Reference to Figure 9 will show how the combined sensory-motor strands make their exit between the vertebræ.

and through which these impulses are returned from the brain to the muscles. The outer regions of the cord are those principally engaged in this conductive function. The central regions contain the arrangements whereby the reflexes are brought about, i.e., the contact of terminals

from the receptors with terminals of the effectors. There are similar synapses of central adjustors, or connectors, with effectors. Thus the motor neurones from the cerebrum

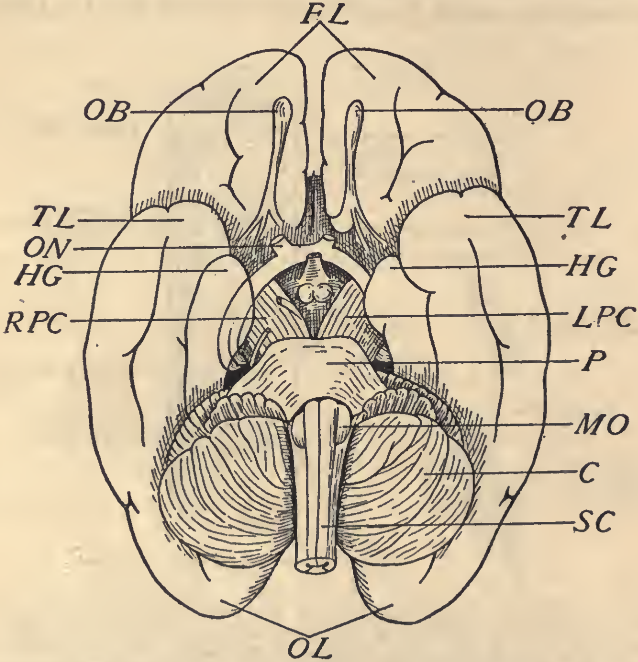


FIG. 10.—The brain seen from below. *FL*, the frontal lobes of the cerebral hemispheres; *OB*, bulb of olfactory nerve; *TL*, temporal lobes; *ON*, optic nerve; *HG*, hippocampal gyrus; *LPC*, *RPC*, left and right peduncles, or legs, of the brain, great masses of fibers; *P*, pons Varolii, or bridge, great band of fibers connecting the two sides of the cerebellum; *MO*, medulla oblongata; *C*, cerebellum; *SC*, spinal cord; *OL*, occipital lobes. (Modified from Edinger.)

discharge over neurones which join them in the gray matter of the spinal cord.

It will, no doubt, be understood that the upper regions

of the cord are connected with the upper portions of the body, and the lower portions with the lower parts of the trunk and with the legs. This is true both as regards the receptors and the effectors. These are both gathered up into bundles which are given off from the cord in pairs between the vertebrae. As shown in Fig. 9, the sensory or receptor group enters the posterior lateral part of the cord,

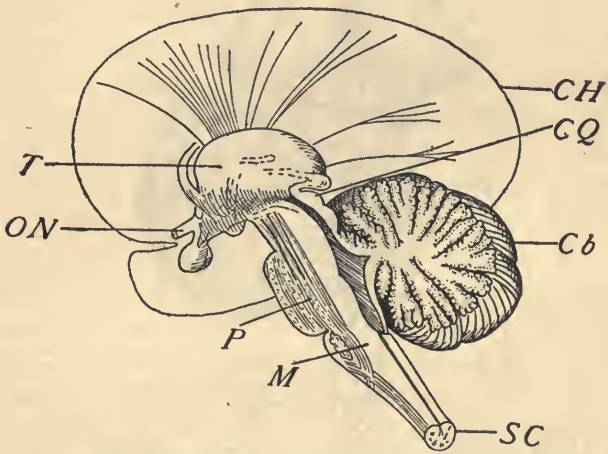


FIG. 11.—Diagrammatic sketch of a vertical section from front to back through the central regions of the hemispheres, cerebellum, brain stem and cord. *CH*, cerebral hemispheres; *CQ*, corpora quadrigemina; *Cb*, cerebellum; *SC*, the spinal cord; *P*, pons Varolii; *T*, optic thalamus; *ON*, optic nerve. The sketch indicates a few of the neurone paths. (Modified from Edinger.)

the motor or effector group is given off on the anterior lateral surface.

At the point where the cord leaves the spinal vertebrae to enter the skull, it broadens out to form the *medulla oblongata*. This structure contains a number of extremely important reflex centers. For example, here are located

the nerve centers primarily responsible for the control of breathing. The rate of the heart beat may also be altered by impulses from the medulla. Furthermore, the distribution of the blood in the body, e.g., as between the skin and the viscera, is controlled from this region.

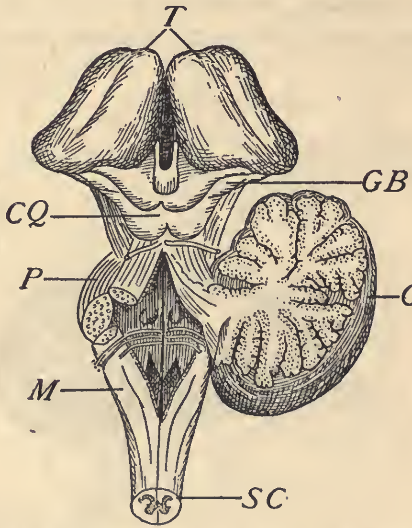


FIG. 12.—A sketch to indicate the general location of the optic thalami. The cerebral hemispheres have been entirely removed and all but a portion of the right side of the cerebellum. *T*, optic thalami. Figures 7, 8, 10 and 11 should be compared with this. *GB*, geniculate bodies; *CQ*, corpora quadrigemina; *P*, a segment of the pons Varolii; *C*, cerebellum; *M*, medulla oblongata; *SC*, spinal cord. (After Edinger.)

As we pass upward, we encounter a number of other conspicuous parts of the brain, such as the cerebellum, the pons or bridge, the corpora quadrigemina, the optic thalami, etc. (See Figs. 10, 11, 12.) The functions of many of these organs are still obscure, and it will be unprofitable for us to give them consideration, with one or

two exceptions. In every case, however, it is to be understood that they consist of masses of cell bodies and fibers similar to those in the spinal cord and medulla.

The cerebellum, whatever other part it may play, is quite certainly responsible for the orderly control of our muscular movements, particularly such as are involved in our maintenance of bodily balance. As we walk, for example, it is clearly essential, if our gait is to be effective, that each of the muscles controlling the foot, knee, and hip should contract at just the right time and to just the right extent. Were the muscles controlling the knee to contract too soon or too violently, one's balance would obviously be disturbed, and a well-ordered pace would be impossible. The cerebellum receives from moment to moment sensory reports of the bodily position, and orders the motor discharges to meet the requirements.

In general those parts of the central system lying below the cerebral hemispheres have to do with our reflex and instinctive behavior. They operate under the general supervision of the cerebrum, a fact which is shown by the exaggeration of their activities when the hemispheres are surgically destroyed, as may happen in certain animals without causing death. The acquired acts depend more definitely upon the cerebrum.

The Cerebral Hemispheres.—Omitting for a few moments some brief comments on the thalami, this brings us then to that part of the brain most intimately connected with mental life, to-wit, the cerebral hemispheres. This is the organ whose great size, relative to the other parts of the brain, distinguishes the nervous system of man and the higher animals like the apes, from those lower down in the scale. In man, too, the *association regions*, to be

FIGS. 13 and 14.

FIG. 13 shows the lateral surfaces of the right hemisphere of the cerebrum, figure 14 the inner mesial surface of the left hemisphere. The latter section is made through the corpus callosum, the right hemisphere being removed. Surfaces covered by colored dots are the so-called motor regions, whence originate neurones in control of voluntary muscles. There are some small and relatively unimportant motor areas elsewhere in the cortex, *e.g.*, in the occipital region some connected with vision. The sensory areas, the receiving stations for sensory impulses from the periphery, are indicated by black dots. The regions most heavily dotted, both sensory and motor, are those most indispensable for the given function. The areas less heavily dotted are those which are less uniformly employed in the exercise of the function, or whose derangement affects the secondary or more complex use of the function. For example, visual images and ideas may be disturbed by injuries in the visual areas which do not seriously impair crude sensations of sight. The areas free from dots are the association regions, which Flechsig has divided into a number of subordinate districts.

R, Rolando, a deep fissure separating the convolutions of *M*, the principal motor regions, from *B*, the somæsthetic sensory regions for bodily sense impressions, *e.g.*, touch, temperature, kinæsthetic. The right half of the body is in general controlled by the left side of the cerebral cortex as regards both sensory and motor processes, and *vice versa*. In the motor-somæsthetic area specific parts of the body are controlled by special regions of the cortex, *e.g.*, the muscles of the legs are controlled from centers lying just under the letter *M* in Figure 13. The speech muscles are controlled from regions near the lower edge of the motor convolution in this figure. Injury to the left side (in right-handed people) is likely to produce motor aphasia, *i.e.*, inability to articulate correctly. The patient is not paralyzed, but cannot pronounce his words correctly. A center somewhat higher up controls hand-writing. These relations are all suggested in Figure 19. *V*, visual center. Injury here may produce various effects depending on its location and extent. Total blindness to half the field of view, inability to read or understand what is seen, without actually being blind, are all found as symptoms of occipital lobe injuries. *H*, auditory center. In right-handed persons injury to the left hemisphere in this region is likely to result in sensory aphasia, inability to understand words when heard. Complete destruction of the region on both sides is said to be followed by total deafness. *O*, the olfactory center which exends in a great loop up over the corpus callosum. The extent of the area is quite uncertain and the drawing simply suggests the facts at present generally recognized. The confinement of motor and somæsthetic areas to the region above the limbic lobe of the corpus callosum is also tentative, although asserted by competent investigators. *O.B.*, the olfactory bulb; *O.T.*, the olfactory tract; *O.T.A.*, occipito-temporal association area; *A.P.*, parietal association area, continuous with the occipito-temporal association area; *A.F.*, frontal association area; *I.*, the Island of Reil, another association area to show which the cortical surfaces just above the fissure of Sylvius have been lifted up; *C.C.*, the corpus callosum, a great band of fibers connecting the two sides of the hemispheres.

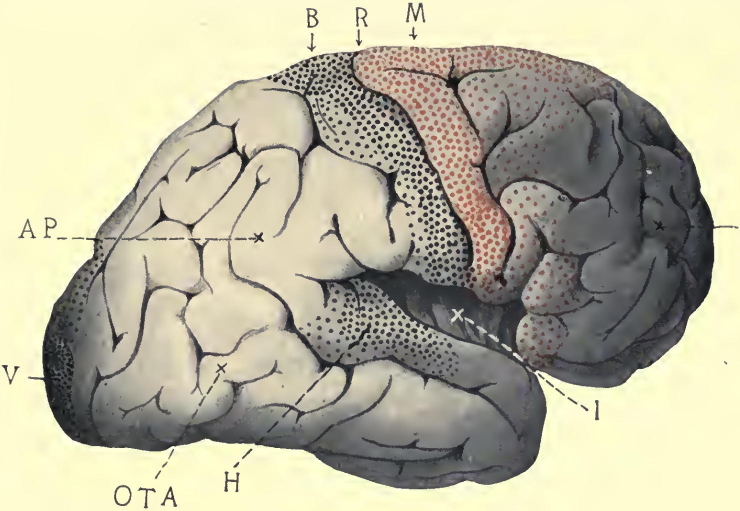


FIG. 13

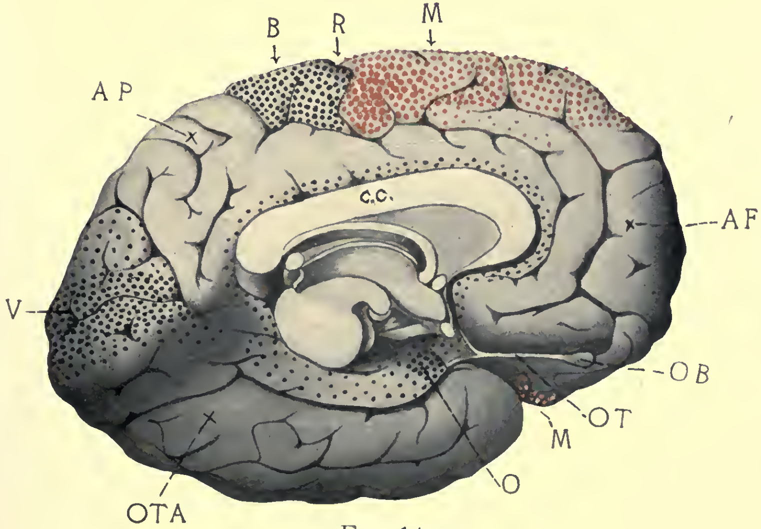


FIG. 14

explained in a moment, are relatively much larger than in most animals. However, man apparently owes his superior intelligence more to the organization of his brain than to its size. As is indicated in Figs. 8, 13 and 14,[1] the hemi-

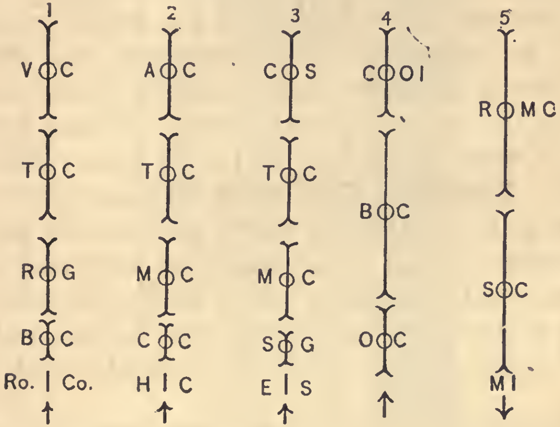


FIG. 15.—Diagram to illustrate the shortest pathways from sense organs to cortex, and from cortex to muscles. No doubt the actual pathways are generally more complex.

Taking the skin nerves as an example of the sensory pathways we find, first, an end-organ in the skin, then a cell in the ganglion outside the spinal cord sending a fiber out to the end-organ and another to the cord. The next neurone has its cell-body in the medulla and communicates with one located in the thalamic region, which in turn communicates with a cell in the cerebral cortex, thus completing the chain from skin to cerebrum. Passing downward from motor centers we find a long fiber extending through the so-called pyramidal pathway (of which the principal crossed tract is shown in Fig. 18) and terminating somewhere in the gray matter of the anterior horn of the spinal cord, where it communicates with another neurone which sends out a fiber to a muscle. A similar arrangement obtains in the case of certain of the muscles of the head, such

[1] These figures and the legends accompanying them should be very carefully studied. The student should understand that the figures and diagrams constitute a highly important part of the text, which cannot be mastered without their use.

spheres constitute by far the larger part of the human brain. Although the neurones which compose them belong to our third adjustor group, it is common to distinguish on the surfaces of the hemispheres, known as the *cortex,* (1) sensory, (2) motor, and (3) association regions. This means that nervous pathways from the sensory receptors *come to the surface* in certain definite zones, that effector tracts leading to muscles originate similarly in other zones, and that the remainder of the cortical structure is composed of nerves which *join* the several regions with one another.[1] Except that all the senses are represented in the cerebral cortex, as they are not in the cord, this general distribution is similar to, although very much more complex than, that of the cord. To be sure, in the cord, the 'white' fibrous matter is all on the outer surfaces, and the 'gray' cellular matter is wholly surrounded by this fibrous

as the ocular muscles, for example, where, however, the immediately controlling neurones issue not from the spinal cord, but from the brain stem. With this explanation and the legend which follows, the diagram will be easily understood.

1, the visual tract; *Ro.* and *Co.*, rods and cones; *BC*, bipolar retinal cell; *RG*, large retinal ganglion; *TC*, cell-body in the thalamic region; *VC*, cell in the visual cortex of the occipital region. 2, the auditory tract; *HC*, hair cell of the cochlea; *CC*, ganglion cell of the cochlea; *MC*, cell in the medulla oblongata; *TC*, as in the visual tract; *AC*, cell in the auditory cortex of the upper temporal region. 3, a cutaneous tract; *ES*, end-organ in the skin; *SG*, cell of the spinal ganglion on the posterior root of the cord; *MC* and *TC* as before; *CS*, sensory cell in the cortex posterior to the Rolandic region. 4, an olfactory tract, different in character from other sensory paths; *OC*, olfactory sensory cell in upper part of nasal cavity; *BC*, cell in the olfactory bulb; *COl*, cell in the olfactory cortex of the hippocampal region. 5, a motor tract; *RMC*, motor cell of the Rolandic region; *SC*, motor cell of the spinal cord, sending down a process to *M*, a muscle.

[1] Figure 15 exhibits certain interesting facts regarding the number and location of the neurones in the important sensory and motor paths.

cover, whereas in the cortex the conditions are exactly reversed. (See Fig. 16.) But the great outstanding differ-

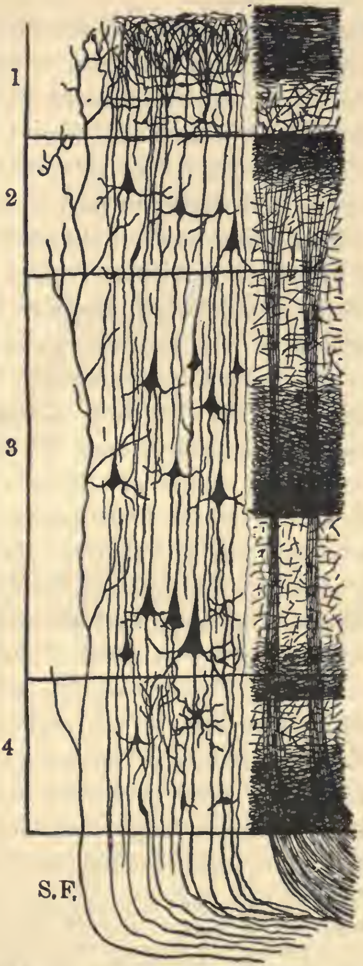


FIG. 16.—Diagrammatic section of the cerebral cortex taken at right angles to the surface. The right side of the drawing illustrates the fiber system alone. The left side illustrates primarily the

ence is found in the fact that *mental processes* are connected with the action of the cortex in a way which seems not to be true of the cord.

Our knowledge of the facts which are now to be briefly stated rests in part upon the teachings of anatomy, which has by dissection worked out the topographical connections of the different portions of the brain, in part upon evidence gained by experimental physiology as a result of observations upon animals, and finally in part upon the findings of pathology, with its discoveries of the effect upon human mental life of injury to particular regions of the brain. While not in every detail harmonious and consistent, the general indications of the evidence gained from these various sources are remarkably uniform.

Consciousness and the Cerebral Cortex.—Conscious memory is apparently dependent upon the integrity of the cerebral cortex. If the retinae are destroyed by accident or disease, blindness is the inevitable result. But memory of visual objects need not be impaired. If, however, extensive injury occurs in that part of the cortex in which the visual pathways terminate, visual memory is obliterated or gravely invaded. Injury to other of the so-called sensory regions exercises a corresponding effect upon the sensory memories appropriate to the region affected. On the other hand, if the tissues of the so-called motor zone are destroyed, control over particular muscles is lost, temporarily, if not permanently. Injuries to the association regions have more ambiguous and irregular

cellular layers. The structure is so complex that it is difficult to display both sets of facts in a single sketch. 1, molecular layer next the surface of the brain; 2 and 3, layers of pyramidal cells; 4, layer of polymorphous cells; *S.F.*, fiber of a sensory neurone entering to terminate in the outer molecular layer. (Modified from Morat.)

consequences. Interesting experiments upon monkeys suggest quite definitely that with these animals, whose brain organization closely resembles our own, injuries in the frontal association zone tend to destroy *acquired habits,* which must then be re-learned. Many observations on human beings had led to the frequent conclusion that these frontal regions were actively involved in the use of attention. The significance of the other association zones is at present somewhat less clear, but brain diseases indicate quite definitely that coherent connection of ideas is materially impaired by derangement at these points. For instance, a patient suffering from a disorder of this type in the parietal association region (see Fig. 13) might find it quite impossible to recognize the meaning of a knife or fork, or to remember the uses to which they are ordinarily put, although in such a case there would be no question of failure to see the object. In the disease called dementia, the tissues of the brain disintegrate and with the disintegration disappears all mental organization.

The attempt has sometimes been made to establish a correspondence between the three great divisions of the neurones which we have described, and the fundamental forms of mental action. The receptors are thus said to correspond to sensation. The effectors are alleged to correspond to the will, and the central adjustors are set over against memory, imagination, and the reasoning processes. In so far as this formulation serves roughly to emphasize certain physiological activities essential to each of these great modes of mental expression, it is unobjectionable. But if understood in any literal and precise fashion, it may be seriously misleading. Although the receptors are indispensable for sensation, the cerebral cortex is also indis-

pensable; and similarly, while the effector nerves are requisite to secure actual expression for acts of will, the motor cortex is quite as necessary, These considerations suggest the real truth about the connection of mental with physiological processes, i.e., that while certain elements in mental life depend in a measure upon specific nervous structures, the entire nervous system is really involved in all mental occurrences. A few illustrations will perhaps serve to make the matter clear.

If with closed eyes one recalls the appearance of some familiar object, we have every reason to believe that the visual regions of the cerebral cortex are active and that they are more indispensable for this particular kind of mental action than any other part of the system. But we have also many reasons for believing that the very process by which we attend to these visual pictures of the object recalled, involves the action of the association areas. Moreover, the securing and maintaining of a bodily attitude favorable to our carrying out this undertaking, e.g., closing the eyes, while holding the large muscles of the body firm and quiet, involves the coöperation of the motor regions of the cortex and the innervation of many of the muscles. Again, to give our attention to a faint sound whose direction and distance we are attempting to determine involves primarily the auditory regions of the cortex; but, secondarily, as we put now this interpretation and now that upon what we hear, the association regions of the cerebrum are certainly involved. Moreover, it is perfectly obvious that the movements of the head which we employ to assist us in determining the source of the sound, are brought about by impulses which in part, at least, originate in the motor cerebral zones. The reader can, no doubt, supply

abundant other instances to support the same general conclusion, to-wit, that the entire cortex is in greater or lesser degree involved in every mental act. The complex interconnection of different regions on the same side of the cortex, and of the two sides of the cortex with one another and with the lower brain centers is indicated in Figs. 17 and 18.

FIG. 17.—Diagram of a vertical cross section from front to back through the central region of the cerebral cortex to illustrate the system of fibers connecting the cortical centers with one another. (James after Starr.)

This 'integrating' action of the cortex by which it brings into a unified organized whole the processes going forward in various of its parts extends also to its supervision over the lower centers. Impulses coming from the spinal cord here combine with other impulses from the organs of special sense, like the eye and the ear, and issue in coördinated motor responses. The highest of these forms of coördination occur when we engage in a pro-

longed and abstruse thought process, involving presumably large demands upon the frontal and parietal association areas. Such a process may then issue in a decision, an

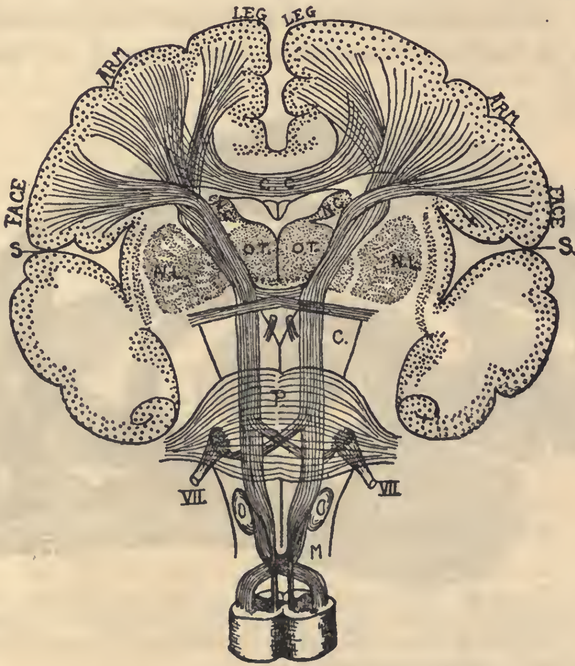


FIG. 18.—Schematic transverse section of the human brain through the Rolandic region to show the crossing of motor fibers in the neighborhood of the medulla. In general the right side of the brain controls the left side of the body and *vice versa*. *S*, fissure of Sylvius; *C.C.*, corpus callosum; *O. T.*, optic thalamus; *C.*, peduncles, or legs, of the brain; *P*, the pons; *M*, medulla oblongata; *VII*, the facial nerves passing out from their nucleus in the region of the pons. (After James.)

act of will, given effect through the muscles controlling speech. Fig. 19 illustrates some simple coördinations executed by the brain in response to sensory stimulations.

Possible Functions of the Optic Thalami.—Recent clinical studies have given ground to believe that certain regions at least of the great group of nervous elements known as the optic thalami (see Figs. 10, 11, 12) are per-

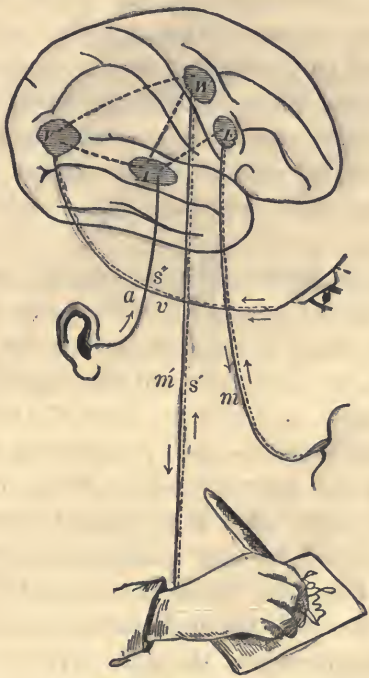


Fig. 19.—Diagram to show the cortical pathways involved when one speaks or writes in response to what is seen or heard. *A* is the auditory center, *V*, the visual, *W*, the writing, and *E*, that for speech. (After James.)

haps the centers upon which the affective parts of our mental experiences depend, i.e., the agreeableness or disagreeableness of our sensations and ideas. The evidence can hardly be called conclusive, but it is certainly very

suggestive and the reader will have observed that no region of the cerebral cortex has been made responsible for these conspicuous factors in mental life.

The Autonomic System.—While our sensations, our memories, our reasonings, and our acts of will are, in a true and proper sense, dependent upon the *central* nervous system, and particularly upon the cerebral cortex, the autonomic system plays a very important part in our mental experience and deserves some further comment. This division of the nervous system got its name because it was supposed to be essentially self-controlling, and self-directing.

The autonomic system, like the central system, is composed of groups of neurones. These neurones, although they differ somewhat in appearance from the nerves of the central system, are nevertheless of essentially similar structure. The largest, and in many ways the most important group, consists of the so-called sympathetic system, which is made up of two great strands of fibers and cell bodies, placed one on either side of the spinal cord, with which they are connected by very complicated arrangements of fibers. (See Fig. 8.) Other groups of these autonomic neurones are found distributed through the viscera and at various points throughout the skull cavity. For example, one highly important group is located in the muscular walls of the heart; another is connected with the walls of the stomach. Still others control certain of the glands and muscles of the eye.

It is through the operations of the sympathetic system that all the great vital processes of digestion, respiration, and circulation are carried forward. The beating of the heart is brought about by nervous impulses which originate

in the autonomic neurones in its own muscle walls, although the rate of the contractions is influenced by the medulla. The contractions of the muscle fibers of the stomach and intestines, the secretion of the various fluids required by the digestive process, these and all the other features of the assimilation of foodstuffs and the excretion of waste products are carried out by the neurones of this system. Inasmuch as these vital functions, including respiration and the circulation of the blood, are ordinarily unconscious, it might seem as though this part of the nervous system were unimportant for mental life. Of course, one can readily understand that only on the basis of reasonably healthful organic conditions may one expect to live a normal mental life, and in so far the dependence of our conscious processes upon the autonomic system is self-evident. But there is a much more significant set of facts to be taken into account.

The most exciting parts of our experience are undoubtedly found in our emotions. So long as our affairs run along smoothly, we hardly ever remark their mental character. But the moment they become in any way exciting, whether they cause us apprehension and solicitude, or the delights of thrilling anticipation, we suddenly become cognizant of a group of factors which under other conditions appear to be wholly lacking. In fear, and even embarrassment, the heart misbehaves itself in a way to attract our painful notice. This misbehavior is occasioned by the neurones of the autonomic system, and without anticipating at this point the more detailed analyses which we shall have occasion to make in a later chapter, we may content ourselves with the general statement that many of the characteristic features of emotion are to be found in

bodily reactions for which the autonomic system is very largely responsible. Recent investigations have shown that in emotions like anger and fear, the secretions of certain internal glands, the adrenals, play a very important part. The activity of the salivary glands and the tear-producing glands in certain emotions will suggest other instances of the glandular accompaniments of states of excitement.

The facts presented in the last few paragraphs will serve to give point to the statement made early in this chapter, that the central system and the autonomic system are most intimately related to one another, and that both are fundamentally significant for the activities of the mind.

CHAPTER IV

CONSCIOUSNESS AND HABIT FORMATION

Relation of Consciousness to Instinctive and Automatic Acts.—One fundamental conception runs through this book, which may be conveniently introduced at once. This is the theory that conscious acts arise amid the hereditary reflex and instinctive acts, like swallowing, crying, sleeping, and pass over into non-conscious habits, such as writing and walking. We may now explain more fully just what is meant by this idea.

The general conception of consciousness as a part of the adjusting equipment of the organism has prepared the reader to appreciate the fact that if the reflex and hereditary responses of the organism to its environment were wholly satisfactory for the maintenance of the life of the individual and the race, there would be no particular justification for the appearance of consciousness, and certainly no available explanation of it on evolutionary grounds. It is a natural consequence of this view to look for the appearance of conscious processes at those points both in individual and racial development where reflex and hereditary automatic acts are inadequate to meet environmental demands.

So far as concerns the history of the individual, this conception seems sound enough. In so far as the needs of the organism are adequately met in the early life of infancy, consciousness is present in only a fleeting and

interrupted way. But as development takes place, the organism is exposed to a large variety of conditions in which the hereditary equipment is hopelessly inadequate to cope with the situation. At such points consciousness is always to be found.

Similarly in the history of the race, the points at which the evidences of mind are most unequivocal are those in which a purely mechanical, stereotyped response of the ordinary hereditary kind, is obviously ill-adapted to steer its possessor and his offspring through the vicissitudes of life.

The general doctrine of this chapter, then, is that once neuro-conscious process has contributed to the establishment of needed coördinations, it leaves its accomplishments behind for use by the non-conscious devices of the nervous system and itself goes forward to new tasks.

Attention has been called in a previous chapter to the fact that the human organism possesses a considerable group of motor activities which are supplied it by nature and which serve the more immediate purposes of supporting life. These acts are illustrated in the various reflexes which are for the most part unconscious, and in those automatic acts by which digestion, circulation, respiration, and the other life-sustaining bodily functions are carried on. Over against these forms of action are the acquired habits, such as walking, talking, writing, and the like. All of these when perfected exhibit at times a considerable degree of freedom from conscious supervision.

Part Played by Consciousness in Learning New Acts. —While one is *learning* to write, consciousness is involved in the most alert and intense manner. The position of the hand, the mode of grasping the pen, the model to be

copied, the movement necessary to form each part of the letter—all these things, one after the other, are the objects of vivid attention. As mastery is gradually gained of now one and now another step in the process, conscious supervision becomes more and more indirect and incidental, until finally, with the acquirement of complete control over the coördination, one is able to give almost exclusive attention to the thoughts which are to be put upon paper, retaining only the most general oversight of the writing act itself.

An acquirement of this kind is spoken of as a habit, and once such a habit is thoroughly mastered, it can be taken up into the formation of a larger habit in which it then becomes a member. Thus a bank clerk is likely to establish a fairly fixed routine for his daily work, which soon becomes habitual; but in this larger habit are included such less automatized acts as writing, adding, subtracting, multiplying and dividing.

This illustration may serve in a homely way to exhibit what is meant by the doctrine formulated above. Mental process seems always to find its appropriate place in connection with the upbuilding of just such habits. When these have become sufficiently perfect, they are passed over almost entirely to the automatic control of the nervous system, leaving the mind itself free to go forward to the creation of other habits, or to the construction of groups of habits in which these smaller components may find a place. Our social and physical surroundings generally change enough to prevent us from reducing our actions wholly to the habitual type. We are constantly challenged to make new adjustments. The mind itself, then, is always moving on to new conquests, is always literally seeking new worlds to conquer. This at least is true in a *bona*

fide way as long as we continue to grow mentally. In the natural course of any human life, there comes a period when we literally cease to grow, followed by a period when our mentality begins to decay. All statements about mental growth must therefore be made subject to the qualifications implied in this situation.

There are certain interesting aspects of this process of acquiring automatic habits or coördinations which it will be profitable to pass in brief review.

Origin and Utility of Spontaneous Movements.—In the first place, then, it should be understood that in addition to the strictly reflex acts, there are innumerable movements of the muscles of the limbs and body made by little babies long before they are really able to control their actions. During their waking moments the muscles of the face, hands, and feet of the youngest children are often in active motion. These spontaneous or random movements, as they are sometimes called, constitute the material of which the later controlled movements are largely composed. In some fashion or other, with the details of which we are frankly but imperfectly acquainted, intelligence steps in and organizes these miscellaneous and somewhat accidental movements into effective coördinated acts. Certain general features of the process we can describe, partly on the basis of our observation of children during the process of their growth in muscular control, and partly by analysis of our own adult performances when learning a new act of skill.

One of the first expressions of voluntary control in a baby is found in the process by which it learns to extend its hand and grasp objects which are seen. *There seems to be a general disposition for all strong sensory stimula-*

tions to drain off into widespread bodily movements. This fact seems natural enough in view of the tendency of sensory nerves to carry impulses forward into muscles. The stronger the impulse, the more widely we may reasonably expect to find its results distributed in the muscle groups. Whether all the movements of hands and arms which one may observe in a young child are occasioned by immediately present sense stimulations, or whether some of them may proceed from a sort of internal nervous explosion, we do not know. At all events it is intelligible that bright and shining objects, such as are first to catch and hold a baby's visual attention, should elicit among other responses vigorous movements of the arms and hands. As a consequence, it is almost certain sooner or later to occur that some of these movements will result in bringing the object seen into contact with the hand. Indeed, parents are sure to expedite and facilitate this outcome by putting objects where they can be readily seized. It so happens that in early infancy there is an essentially reflex tendency to close the hand upon objects which stimulate the skin of the fingers and palms. So strong is this reflex that newly born infants can sustain their own weight by grasping a small rod.

Establishment of Successful Coördinations.—There is a good deal of diversity of opinion among psychologists as to the processes which intervene between this initial experience of grasping an object seen, and the final achievement of the skilful control possessed by adults. There can be no question that in the early stages of the development of such a habit there is often a condition of great excitement and keen pleasure. Such conditions seem favorable to the rapid stamping in upon the nervous

system of those impressions which will conduce most quickly to the securing of an automatic habit. Certain it is that either lack of interest, or the presence of painful sensations at any stage of the process, tends to discourage and disintegrate the growing coördination.

It must not be supposed that success in one attempt necessarily implies equal success in all succeeding attempts. In general, the progress from the initial stage to the perfected habit is slow and irregular, and in the case of the great majority of the motor accomplishments of little children is brought about by a process known to psychologists as trial and error, and in ordinary parlance, as 'try, try again.' In certain forms of adult learning, of which we shall have something to say at a later point, there is an obvious attempt to make use of reflection and reasoning, to see how and why a particular movement ought to be made and then to go about the making of it. But in these primitive forms of acquiring control, the first method is chiefly in evidence.

In one and all these cases, the point to be carefully borne in mind is that during the learning stage there is a very vivid consciousness of what is going on step by step; whereas after the act is substantially mastered there may be only the most indirect and casual conscious supervision.

Elimination of Useless Movements.—One striking feature distinguishing the earlier from the later stages in these learning processes is found in the presence at the outset of large numbers of superfluous movements, some of which are merely useless, while others actually hinder progress. In the perfected habit, almost all of these have been eliminated. It is as though Nature called out from

the organism a surplus of movements, among which may haply be found the little group indispensable for the specific purpose in hand. The process of establishing the coördination consists, then, first in the selection and fixation of the essential motor elements from among movements actually occurring, and second, in the gradual elimination of those which are needless. Abundant confirmation of these statements may be found in observing a child while he is acquiring control over almost any motor dexterity. Writing, as we have already suggested, is apt at the outset to involve a great mass of perfectly needless movements of head, tongue, shoulders, and body. Slowly these fall away, until there are left substantially only such motions as are really required. Gracefulness has sometimes been declared to depend upon the use of only essential movements. However true this definition, it certainly may be adopted as a just description of economic efficiency. It underlies all the attempts to secure maximal efficiency in industrial occupations.

Habit and the Sensory-Motor Circuit.—The mechanism of many of these habitual coördinations which stop just short of becoming entirely automatic and non-conscious, seems to depend upon the linking together of sensations and movements in a manner which may well be briefly described. In learning to ride a bicycle, for example, considerable groups of muscular movements are necessarily combined. Everyone who has gone through the experience will probably recall that one of the early difficulties consisted in remembering to push downward with one foot at just the appropriate moment, as reported by *sensations* from various parts of the body, particularly from the knees and ankles and soles of the feet. One quickly

learned, however, to respond to these signals and to make the corresponding downward thrust with the proper foot. As soon as this interconnection of sensations and movements is firmly established, the process of pedalling largely takes care of itself, and the entire attention may be given to learning to balance. Until this point is reached, many beginners find themselves with feet in the air or 'back-pedalling' to the entire defeat of their forward progress.

The accompanying diagram (Fig. 20) may serve rudely

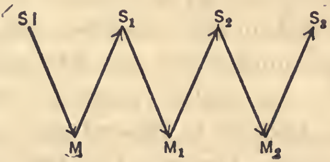


Fig. 20.—Diagram to illustrate a series of motor discharges in response to sensory or ideational stimulations. *SI*, a sensory or ideational stimulus; *M*, a motor response; S_1, a sensory disturbance occasioned by the movement M; M_2, a motor discharge consequent upon the stimulation S_1, etc. In an act like skating two general sets of alternating movements may be repeated again and again. In such an act as signing one's name each of the movements may be different from the others.

to illustrate this situation. When a movement is made, we become aware of it partly through the sensations which are aroused in the muscles and joints of the member moved, and partly by means of sensory effects impressed upon other sense organs. Either type of sensation may be used to serve as the signal for the next movement. In playing a musical instrument there are thus aroused not only sensations in the skin of the hand and in the muscles of the hand and arm, but also sensations of sound; and if the eyes are properly directed, there may be a visual report of

the movement. Any or all of these sensations may serve as signals for the series of movements. Where habits have become highly automatized, it seems probable that this same type of sensory-motor mechanism is employed, but that in some manner it short-circuits the higher cerebral regions, so that we are much less definitely conscious of the process.

CHAPTER V

ATTENTION

The previous chapters have brought to the reader's notice the conception of life as adjustment, and have explained the dependence of the mental parts of the adjusting process upon the organization of the nervous system. We must now turn to a more intensive and detailed analysis of this process.

Attention as Adjustment.—When an animal organism is subjected to a strong physical stimulus, for example, an acid, it instantly displays protective movements, generally of retreat. Such movements are obviously of an adaptive character. Man, under similar conditions of stimulation, by strong lights, extreme temperatures, loud sounds, and the like, also manifests adjustive responses. In this case, however, as we all know from personal experience, these adaptive reactions are accompanied by the mental state which we call attention. Attention is, indeed, the most general attitude of adjustment, and we may profitably direct our thought to certain of its more important characteristics.

We seem to be so organized that, regardless of our momentary occupation, any sense stimulus of sufficient violence may force its way over the receptors and into the cerebral cortex, where it may displace the dominant nervous activities and itself take possession. Such a nervous assault upon the brain results in our becoming aware of the object acting as stimulus, produces what we call attention

to it. Now it is an interesting fact that, as part of the process of attending, the action of the nervous system evokes certain muscular adjustments, as a consequence of which we become more definitely and distinctly aware of the stimulus. To illustrate, if a strong light strike the eyes from the side, there is a rotation of the eyeballs and often a turning of the head, as a result of which the eyes are put in the position of clearest and most distinct vision. At the beginning of the process, we may have been aware only of the vague but strong impression of light and color. As the eyes turn and we are able to see distinctly, we secure an impression of the luminous object which is both vivid and clear. Such an impression affords us, as the original powerful but indistinct impression did not, information as to the character of the object, and we are forthwith in a position to determine intelligently our next movement.

Any strong stimulus constitutes a more or less imperious invitation to an adjustive response. Figuratively, at least, and often literally, such a stimulus is in the nature of a problem which we are called upon to solve. Certainly it presents in a fair sense a difficulty which we must surmount. The first step in the process of mental adjustment is always attention, and as our previous discussion has suggested, this adjustment will normally be found to involve motor reactions designed to put us in a position of more distinct and complete perception of the situation.

Attention as an Organizing Activity.—Our ordinary language tends to create a somewhat misleading impression concerning attention, because it suggests that attention is a separate force or entity which may suddenly step in and direct our mental processes. Thus we say that attention wandered, or that it was concentrated, and properly under-

stood such phrases are perfectly correct. Evidently these expressions imply that attention is simply preparatory mental and motor adjustment. It is an act, not an agent. It is the process in which is mentally organized whatever is at the moment presented. This fact is made clear by observing that we may attend to one and the same physical object in a number of different ways, depending upon the manner

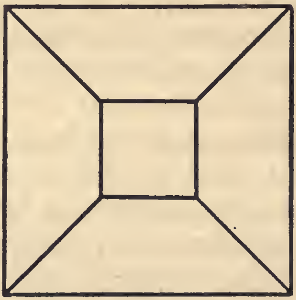


FIG. 21.

in which mentally we organize its constituents. For example, Fig. 21 may be attended to as a picture frame, or as a truncated pyramid, with the apex toward the observer, or as a square tunnel into which one is looking. So far as the physical object is concerned, the lines are in each case one and the same. So far as concerns the stimulation of the retina the situation may be wholly unchanged in the three instances. But our mode of attending is in each case quite distinct, because we organize and interpret the lines from three different mental points of view.

The Field of Attention.—Psychologists have been particularly interested in one aspect of attention about which a few words must be said. When one is reading, at any given

moment a certain word or group of words stands out with greater clearness than the rest of the words on the page, while outside the page altogether, one may be dimly conscious of objects in the outer part of the field of view. Moreover, as one reads, ideas more or less disconnected with the words to which one is dominantly attentive may from time to time intrude themselves. This situation has been described by saying that the field of attention has a focus and a margin. The focus is comprised of whatever may be at the moment clearest and most distinct in consciousness. Outside this focal region there is a margin of indefinite extent, made up of materials which are decreasingly clear as one passes away from the focus. Observers differ as to the number of discernible zones of clearness. Some persons report only two regions, one the central region of maximal clearness, the other the entire remaining portion of the field. Others maintain that three or four or even more distinct areas may be distinguished, differing in clearness all the way from the central focus through progressively dimmer and less distinct regions to a margin which is essentially unconscious. Fig. 22 will suggest the sort of thing here described.

The Range of Attention.—The conception of attention as a process of adjustment would lead us naturally to expect that we should at any one instant be able to attend only to a small group of objects or ideas. It has often been urged that we can attend to only one thing at a time, and there is perhaps a sense in which this is true, but it involves recognizing the fact that this 'thing' may be quite complex, and may involve what under ordinary conditions we should regard as a number of objects. A few illustrations will perhaps make the matter clear.

A person playing the piano from a printed score may seem to be attending to a great many different things at once. The eyes take in several groups of notes and then perhaps are quickly turned to glance at the hands and keyboard. In looking at the music, a considerable number of separate notes may be taken in at a glance, each of which indicates a particular movement of a particular fin-

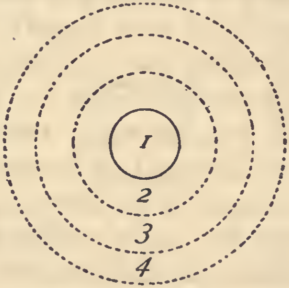


FIG. 22.—1, the focal region of attention; 2 and 3, zones of less distinct awareness; 4, the region of subconscious processes.

ger, together with the time value and the stress with which the key is to be pressed down. Such a situation appears to involve attending simultaneously to a large group of objects, but it would involve a misapprehension of the actual situation to suppose that in any one moment they were perceived as so many separate and distinct things. By long training the eye has been taught to take in groups of notes in a single sweep, exactly as it takes in the groups of letters which compose a short word. The response of the fingers to what the eye sees is in the same way the result of long and painstaking practice, and the proficient performer does not require to give separate attention to each movement. Obviously there is a very real difference between attend-

ing at any one moment to a large number of objects and *doing* at one and the same instant a considerable number of different things. The limit of our ability to perform complicated simultaneous movements as a result of practice would be hard to set. Certainly the least skilful of us can master a good many such movements. But however complex the object to which we attend, apparently the process of attention serves to bring together into a sort of mental unit all the different parts. How many such parts can actually be united is only to be determined by experiment. Four or five dots placed close together on a piece of paper can be seen in a single glance. If they be gradually spread somewhat further apart, it will soon be difficult or impossible to see them without breaking them up into successive groups. Similarly, six or seven, or even eight very rapidly succeeding sounds may be heard as a unit. If the sounds be given more slowly, they will begin to break up into smaller groups.

There is no serious difficulty in determining by experiments what are the facts about this so-called range or scope of attention when we are dealing with physical objects. It is much more difficult to speak with certainty about our ability to attend to groups of *ideas*. When one's mind is engaged upon the solution of a problem, ideas may flow through it with amazing rapidity, and we often speak as though while thinking about certain parts of a problem, we kept the rest of it constantly before us. Suffice it to say that most psychologists are agreed that the situation is substantially identical with that already examined in the case of attention to objects. However complex an idea may be, attention at any given instant is probably always occupied with one such idea and its immediate relations.

The Duration of Attention.—This discussion leads very naturally to another issue which has always interested psychologists, i.e., how long can we attend to any one thought or thing? Common opinion would lead one to suppose that we may attend almost indefinitely. Certainly we speak of having had this, that or the other thought in mind for a long time. In the same way we say, "I have been watching that bird for ten or fifteen minutes," implying that our attention has been unchanged through all that period. In a practical sense, no doubt both types of statement are sufficiently accurate. But a very brief scrutiny of the actual facts in such cases will give us quite a different impression of what it is that occurs.

Careful observation will show that what we might justly enough speak of as 'attending to a bird' involves in reality attending to an ever changing series of facts about the bird. We note now the color of his wings, now the shape of his tail, now the movement of his head, and now his change of position from one branch to another. If we attempt to focus our attention rigidly upon any single feature, such as the shape of his beak, suddenly and without intending it, we are noting some other feature; or, to our surprise, we may find that some totally disconnected thought has bobbed up in our minds and taken off our attention. In the same way, if we examine what occurs when our thought is supposedly riveted upon some particular idea, we shall discover that in actual fact a great series of ideas has passed through our minds, each of which was perhaps related to the thought with which we were ostensibly occupied, but each of which is quite certainly a separate thought. In other words, our attention moves very rapidly and never in any literal sense lingers long

in one place. How long it remains it is very difficult to say. Experiments would indicate that a few seconds is ordinarily the outside limit.

Attention and Organized Reaction.—If we now turn back and recall the assertion that attention is essentially a process of adjustment, we shall see very good reason why the attentive act should tend to bring together into a single mental object as many as possible of the separate elements to which adjustment must be made. We can also discern a reason why attention should be relatively brief in its duration.

In primitive animal conditions, adjustment implies an immediate response to a present situation, and generally a situation in which some localized stimulus demands a localized response. Even in the life of man, the ordinary sensory stimulus demanding an adjustive activity requires a localized reaction. A blow upon the hand demands an adjustment which will promptly remove the hand from danger. The sight of food similarly requires a localized type of response designed to secure it. In the higher animals, and particularly in man, many of these adjustments find their crucial significance in *future* reactions, in *delayed* responses. You make a decision today which you cannot execute until tomorrow. In each and every case the *reaction,* whether immediate or delayed, must be *organized* to be effective, and it must have relation to a situation which is a unit in the sense that it requires a particular kind of response. To attend to putting air in your automobile tires involves attending not to the tires in general, but to each one separately, and to a series of particular acts in each case—unscrewing the valve cap, blowing out dust, screwing on pump pipe, etc.

In so far, then, as attention represents the first step in the adjustive act, we should expect to find it grouping together all those elements in a situation to which we can profitably *make a single organized response.*

For much the same reason, we can understand why attention dwells so briefly on any one feature of a situation. It is itself the preliminary stage of psycho-motor adjustment, and its work is done as soon as it has stamped the elements of a situation with that kind of organized unity to which a response can be made. It is, therefore, quite inevitable that attention should move forward with considerable rapidity. That we are unable wholly to control its behavior in this respect can be readily shown by a simple type of test. Put a pencil dot on a blank sheet of paper and try to attend to it uninterruptedly. So simple a thing ought readily to be retained in the focus of the field of attention. The reader can easily convince himself what actually occurs by making the experiment. An instructive variant can also be tried by attempting to fixate for not less than a minute one of the shorter words on this page.

Motor Aspects of Attention.—An interesting confirmation of the conception of attention we are presenting is found in a consideration of certain of the motor accompaniments of attention. Clear vision is normally dependent upon an elaborate set of muscular acts. The eyes must converge and the muscles controlling the lenses must be innervated in order that we may see distinctly. Similarly, when we are listening we tend to turn the head so as to catch the sound more distinctly, and in the case of faint sounds, we hold our breath. Our animal ancestors commonly turn the external ear to assist their hearing, an

art which we have largely lost. Odor cannot be detected unless the odorous substances are drawn up into the nostrils, and this is ordinarily accomplished by a vigorous inhalation. To get the taste of an object clearly, we press it with the tongue against the roof of the mouth. To detect the contours or surfaces of an object, we pass the finger tips over it. In all these cases a maximum of distinctness and clearness is gained by motor activities.

Less obvious, but not less real, and probably not less significant, are the motor expressions in cases where we are attending to ideas and thoughts rather than to physically present objects. The facts are here more difficult of access, and the reader must expect to be left with less of certainty regarding them. A little observation, however, will show that each of us, when thinking hard, tends to adopt certain bodily attitudes which are more or less characteristic and which seem in some way to aid the thinking. Some people frown under these conditions, others walk up and down, others wish to be seated with their feet up in the air. Still others bite their finger-nails, or tap with a pencil upon the table. Most of these performances are attributed merely to bad nervous habits. But fundamentally they are probably much more than that. They may well represent protective devices to guard the thinker against interruption, partly by putting him into a position of physical comfort, and partly by supplying him with a group of self-controlled but reasonably vigorous sensory stimulations which may perhaps serve to overwhelm any purely outside sensory disturbances. A portion of these reactions may be regarded as occasioned simply by the overflow of unused nervous energy, which might possibly be saved to advantage. There can be little

question, however, that whatever the individual history by which such muscular activities have been taken on, their absence or suppression is a source of marked discomfort and disturbance to the thinker.

There is another group of these motor reactions belonging to ideational processes which has a different and somewhat more obvious explanation. For many people the attempt to think with closed eyes of some object to the right or to the left will occasion a movement of the eyeballs in the corresponding direction. Similarly, to think fixedly of a sound as coming from a point behind and to one side will produce in some persons a strong tension in the muscles of the head and neck, if it does not, indeed, occasion an actual turning of the head. Clearly this type of motor expression is simply a carrying over into *ideational* processes, as a matter of habit, motor forms of behavior which have an evident adjustive value in the case of sensory attention.

It is rather the usual custom for psychologists to speak, as we have already once done, of these motor reactions as 'accompaniments' of attention. In point of fact, while they are accompaniments in a true enough sense, it would be a mistake to think of them simply as companions to an entirely different process. It is a truer view to regard them as in a genuine sense merely the external expression of the adjusting agency which, felt from within, is attention. 'The stretching out to meet' which is the original linguistic meaning of the term attention, is precisely and exactly embodied in these preliminary motor adjustments whereby we organize and in a sense determine the object to which we have to adjust. In the lower and more reflex types of reaction, this immediate motor response exhausts

and completes the adjustment. In the higher and more conscious types of behavior, it simply sets the stage and determines what is the object or the situation to which in a larger way immediate or delayed adjustment is to be brought about.

Classification of the Forms of Attention.—Various classifications of the forms of attention have been proposed, a few of which deserve brief mention.

(1) An old classification distinguishes *sensory* from *ideational* attention, the former illustrated by any case of attending to sensations of color, sound, contact, and the like, the latter exemplified by attention to a train of thought. Obviously this division is based on differences in the objects of attention, rather than on differences inside the attentive process itself.

(2) Another distinction marks off *immediate* from *derived* attention. When a thing attracts the mind because of its intrinsic interest, or its capacity to excite, attention is immediate. When we attend because of some secondary consideration, attention is derived. To attend to one's study because one is interested in high marks affords an illustration of derived attention. Attention to a thrilling narrative will illustrate immediate attention.

(3) A distinction is often drawn between *active* and *passive* attention. The significant points in this classification are preserved and somewhat improved upon in the division of attention into three classes (a) spontaneous, (b) involuntary or forced and (c) voluntary.

Spontaneous attention is substantially synonymous with immediate attention and is illustrated in the attention given by babies to bright lights and loud sounds, by

adults to hunger, to crowds, and to innate tastes, such for example as music. It is undoubtedly the primitive form of attention, out of which the others have grown.

Involuntary, forced, or passive attention is illustrated in the compulsion exercised over the mind by very intense sensory stimulation. One may be absorbed in a good book (spontaneous attention) and suddenly be shocked into a forced attention by a clap of thunder. Morbid ideas sometimes intrude themselves in the same way.

Voluntary attention (closely resembling *derived*) is represented by attention given as the result of definite effort. Anyone who succeeds in holding himself to a distasteful task exercises voluntary attention in this meaning of the term. This is a form of attention that develops whenever the mind becomes mature enough to appreciate and entertain two conflicting interests or lines of conduct. Choice must be made. One must be for the time at least put aside and the other encouraged. Spontaneous attention early provides these competitive bidders for attention, and voluntary attention springs from such a soil. The effort to suppress disturbing appeals to forced attention obviously offers another field for the development of voluntary attention. Fortunately for our peace of mind, many experiences to which we attend at first only with effort and discomfort become after a little time intrinsically interesting and agreeable, whereupon we give them essentially spontaneous attention.

Analysis and Synthesis in Attention.—Attention subserves two great functions which psychologists have commonly designated (1) analysis, discrimination, or dissociation, and (2) synthesis, or association. Every act of attention in a sense involves both of these processes, al-

though at any given moment one or the other generally seems to be dominant.

As the reader's eye passes across this page he will, in the very act of reading, necessarily separate the printed letters into words to which he attends either singly or in groups. That his attention is given to the separate words at all instead of to the shape of the page, the color of the paper, the details of the background against which the book is seen, is a consequence of the fact that out of all the possible objects before his vision he has selected those special parts which correspond to the words, and has in turn given his attention to them in their context rather than in isolation. At any given moment, vast numbers of stimulations are attacking the various sense organs. Sounds, colors, contacts of various kinds, are simultaneously impressed upon ear, eye, and skin; and yet we are aware of only a trifling fragment of all these stimuli. The organism selects from out this great range of possible objects of attention those which shall at any moment be heeded, and neglects the rest. From the descriptions which have preceded, the reader will readily comprehend that the clue to an understanding of why certain objects are chosen for attention and others neglected is to be found in the demands for adjustment. The adjustive process can hardly be carried out in response to objects in general. It requires that now this element in the situation and now that shall be given consideration. The primitive form of analysis, discrimination, or dissociation, is simply the isolating of a particular portion of the environment to which an organized motor reaction can be brought to pass. One cannot adjust to visual things in general, but one may make a movement of the hand designed to grasp some par-

ticular visual object. Similarly one cannot adjust successfully to a miscellaneous jumble of sounds, but one can step back to avoid the annihilation foreshadowed by the screech of an automobile horn.

It should be fairly obvious from these illustrations and the dozens of others which will readily suggest themselves, that effective guidance of an organism amid the vicissitudes of a physical and social world such as that in which we live, necessitates such a selective analytical process as we have described. Every act of attention, when scrutinized, will easily be seen to involve this same type of discrimination, this same breaking up into parts of the great complex world of objects, with their various appeal to smell, taste, touch, sight, and hearing. Our illustrations have all been chosen from instances of adjustment to *sensory situations,* but the same dissociative or analytical process is to be discerned in our attention to *ideas* of all kinds. This fact is peculiarly evident in cases where we are thinking intently in the attempt to solve some difficult problem. In such a case, our thinking is often directed to the analysis of the thoughts which present themselves. The more intimate description of these ideational processes will be taken up later after a study of some of the simpler phases of our mental organization.

Contrary to the formerly accepted views, the prevalent opinion of psychologists today is that the consciousness of the new-born child, and presumably that of the simpler organisms, is characterized by a somewhat vague blending or fusion of many elements, like colors and sounds, which to the adult appear clearly separate and distinct. The transition from the conditions of infancy to intellectual maturity is in large measure dependent upon the execu-

tion of these acts of discrimination and analysis just described.

Conditions of Discrimination.—We know with great certainty that colors are at first distinguished from one another by babies imperfectly or not at all. There is similar evidence for believing that the components of many sounds are thus undistinguished; and in general there is good reason to suppose that at the outset of life an indefinite number of sensations may fuse together, provided only that the stimulations occasioning them fall simultaneously upon the sense organs. Even in adult life certain of these fusions persist in the most obstinate manner. Apparently only those sensations separate which are forced to do so by the exigencies of adjustment. For example, owing to the proximity of the sense organs and the character of the stimuli affecting them, it comes about that a large proportion of the food substances stimulate both the organs of taste and those of smell. The supposedly characteristic tastes of many familiar beverages and foods are as a matter of fact due to sensations of smell and not to taste at all. Coffee, tea, onions, apples, and asparagus lose almost all their more agreeable and individualistic features, if by reason of a cold or by artificial stoppage of the nostrils, one is prevented from getting any odor sensations. Other instances of fusions which persist even in adult life may readily be found in the combinations with one another of pressure and temperature sensations from the skin, and of both with sensations of movement originating in the muscles, tendons, and joints.

We have already mentioned the belief that only such sensations separate as are forced to do so, but the conditions under which such dissociation may be brought about

remain to be stated. If a sensation or group of sensations is to be separated out from a larger matrix so that we may adjust to it independently, it is apparently necessary that it shall be experienced alone or in a different group. We may express this in a symbolic way by supposing that three sensations, x, y, and z, occur together. The principle formulated would require that if x is to be successfully analyzed out of the compound it shall be either experienced alone or in some other group, such as xrs. In the case of colors, for example, this would mean that if red, blue, and green were always experienced together, they would presumably never be differentiated, and the precondition of their dissociation from one another is that they shall be experienced singly or in other combinations. If we translate this formula into terms of nervous activity, we shall see that it means that we can only discriminate differences when the nervous circuits involved are different. Obviously the changing conditions in the physical world must speedily bring about the necessary variety in the combination of sense stimulations required by this theory of analysis in order satisfactorily to explain our actual success in discrimination. It need hardly be pointed out that at an early stage of its development the human organism, at least, secures the power to bring about artificially many of these conditions of changed stimulation by its control over its own movements. It is thus possible, for example, by pinching the nostrils, to cut off the larger part of our odor sensations and thus experimentally to split up the smell-taste fusion to which we have referred.

Reciprocal Relations of Association and Dissociation.—Every process of analysis may from one point of view be

thought of as an act of synthesis or association. The mental process by which one distinguishes the black and white colors on this page is one in which, by the very nature of the case, the two qualities thus distinguished are brought together and associated with one another. Analysis and synthesis are, therefore, conjoint processes involved in every act of attention. Nor does this tell the whole story. When one gives his attention to a word on this page, his mental act unites into a single mental whole, each of the letters which goes to make it up. The process of dissociating the word from the rest of the field of vision is one whereby the components of the word are also integrated into a single object. It will be found that this conception is applicable to all types of organic adjustment.

Analysis and synthesis, association and dissociation, are thus, as it were, the two blades of the scissors which we call attention. Both are invariably involved in every attentive act. Sometimes we are more interested from the practical point of view in analysis; sometimes in synthesis. But in either case our actual mental procedure depends upon the employment of both.

CHAPTER VI

SENSATION

In the account of adjustive processes we have constantly referred to the fact that man is supplied with sensitive organs which are capable of responding to various kinds of physical stimulations. Light, heat, sound, contact, are illustrations of the stimuli to which the organism is able to react. No doubt there are many forms of physical action to which we are entirely insensitive. Magnetism is an example of such a force, for which we have no appropriate receptor. Connected with the use of these sense organs, are the most rudimentary of our mental processes, and it is therefore natural that we should begin our more exact analytical study of the mind at this point.

The Development of Sense Organs.—If we turn to evolutionary history, we find that our equipment of sensory organs presents a most interesting picture of the development of highly specialized senses out of a very crude general sensitivity. The simpler organisms, like the amoeba, are more or less sensitive to the various forms of stimulation which affect human beings, e.g., light, temperature, contact, but there are no specific sense organs of any kind. As we pass up the scale in animal life, we find the rudimentary vestiges of the specialized organs which later become the eye, the ear, and the other senses. These present the most varied assortment of devices for accomplishing their purposes. The eye, for example, which makes

its first appearance as a little pigmented speck on the surface of the organism, passes through a great number of different forms before it takes on the character of the highest vertebrate eye, like that of man, with its system of lenses for bringing light to a focus upon the surface of the retina. There is, moreover, very considerable variation in the structure of the eye in different vertebrate forms like the fishes, the birds, and the mammals.

The other sense organs display a similar evolutionary history, although some of them, like the ear, have developed very much further away from their primitive forms than have others, such as those of contact and temperature. We may conveniently begin our study of the sensory processes with vision.

The Organ of Vision and Its Stimuli.—A complete knowledge of vision implies a detailed acquaintance with the anatomy and physiology of the eye. Evidently, under the present conditions, we must forego any exhaustive study of the subject, and content ourselves with relatively rough impressions such as can be secured in the time at our disposal.

The stimulus to vision consists normally of light waves constituting the sunlight spectrum from red to violet. These waves vary in rate from approximately 435 to 769 billions a second. An electrical current passed through the head will also produce sensations of light, as will a violent blow. The light stimulations are classified as either homogeneous or mixed. Homogeneous light is made up of waves of approximately equal vibration rate and equal length, and is represented by the pure colors of the spectrum, such as red, blue, green. Mixed light finds its most frequent exemplification in the ordinary white light of the

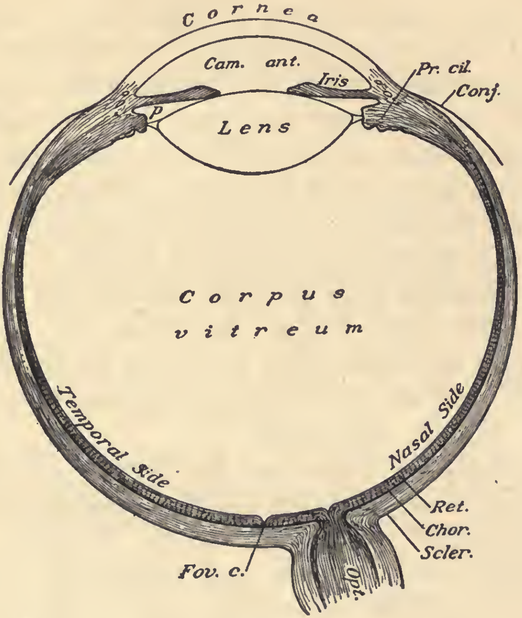


FIG. 23.—Horizontal section showing *Opt.*, fibers of the optic nerve entering the back of the left eyeball to spread over its inner surfaces; *Fov. c.*, fovea centralis, the point of most acute vision in the retina on which are centered rays of light from any object at which one is looking. Only cones occur in this region. *Scler.*, the sclerotic coat, tough and opaque, transformed on its anterior surfaces into the transparent cornea. *Chor.*, the choroid coat, carrying blood vessels and a heavy dark pigment. *Ret.*, the retina, terminating at a little distance from the lens. *Pr. cil.*, the cilary muscle processes which control the convexity of the lens. The ligament in which the lens is suspended may be seen, just under the letter "p," which marks the posterior chamber behind the iris and *Cam. ant.*, the anterior chamber, both filled with aqueous humour. *Corpus vitreum*, the humour of the main cavity of the eyeball. *Conj*, the conjunctiva, a very thin mucous membrane. (After James.)

sun. As a matter of fact, there is always under ordinary conditions of vision an appreciable amount of mixed light even when we are looking at the simple colors. To the homogeneous lights we owe, then, the various distinguishable hues of the spectrum (each one corresponding to a particular wave length or vibration rate), and to mixed light the series of colors from white through gray to black. The amplitude of the light vibration determines the intensity of the resulting sensation.

Figure 23 represents a vertical section front to back through the center of the human eye. It reveals, with reasonable clearness, all the more important structures. The eye is a roughly spherical camera, into which light is admitted through a small aperture at the center of the front surface. The general form of the eye is preserved by the sclerotic coat, the tough outer covering of the eye, which is transparent on its front surfaces, known as the cornea. Inside it is the choroid, a dark pigmented coat absorbing light rays and carrying many blood vessels. The rays of light are bent or refracted by the spherical surface of the cornea and again by the surfaces of the lens, so that they come together upon the retina, lying just inside the choroid, to form a well-defined image, such as appears on the photographic plate of a camera when the lens is properly focused upon its object. Unless this image is clear and sharp, vision will be blurred. In the photographic camera, the focus is adjusted by moving the plate toward, or away from, the lens, as may be required. In the eye, the distance between the lens and the plate, i.e., the retina, is fixed and unchangeable. The focusing is in this case brought about by an extremely ingenious device. The lens is an elastic, gelatinous structure of spherical

form, enclosed in, and suspended by, a very thin transparent membrane. This bag-like membrane is attached to muscular tissue on the inner surface of the eye-ball. By the contraction or relaxation of these muscles the membrane is rendered more or less taut. As a result of this change of tension, the lens is made more or less convex, more or less spherical in shape. Anyone familiar with the manner in which lenses bend or refract the rays of light passing through them will understand that this changing convexity permits the securing of clearly focused images

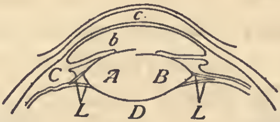


FIG. 24.—Sketch to illustrate the mechanism of accommodation. *A*, the lens accommodated for a near object, its anterior surface advanced; *B*, the lens at rest, accommodated for a distant object. *C*, the ciliary muscles controlling the ligament, *L*., supporting the lens; *c*, the cornea; *b*, the anterior chamber; *D*, the vitreous humour of the main cavity of the eyeball. (After McKendrick and Snodgrass.)

on the retina, just as readily as is the case in the photographic camera, where, the lens remaining stationary, the plate is moved to and fro. The more convex the lens, the more sharply the rays are bent, and the more quickly they come to a focus. As an object approaches the eye, the lens must become more and more convex, if the image of the object is to remain sharply focused upon the retina. (See Fig. 24.)

The Retina.—The central part of the retina, upon which these images fall, is known as the fovea, and is the region of clearest vision in the eye. It is characterized by a slight

depression and the presence of a slightly yellowish pigment. From the fovea toward the lens, the retina becomes progressively less capable of affording clear, distinct vision.

As the sketch indicates (Fig. 25), the fibers of the optic nerve enter the eye-ball from its rear surface, and

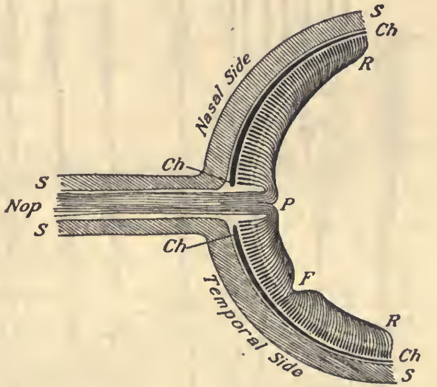


FIG. 25.—Horizontal section of right eye showing retinal fibers. *Nop*, optic nerve; *S*, sclerotic; *Ch*, choroid; *R*, retina; *P*, blind spot, no retinal structure present; *F*, fovea, point of clearest vision The retinal fibers are shown turning back to meet the pigment layer of the choroid. The light coming in through the cornea, lens and optic humours, passes through the optic fibers *before* it reaches the rods and cones on the inner surfaces of the retina. (James after Kuss.)

there spread themselves in cup-shape, all over the surfaces of the inner part of the eye. The fibers turn toward the outside of the eye, and terminate in the very complex structure constituting the retina, of which Figure 26 gives a vertical cross-section. The actual sensitive organs which the light stimulates after passing through the optic fibers and the inner parts of the retina are the so-called rods

and cones, whose shapes explain the names given them. In the fovea, cones alone are found. In the forward regions of the retina near the lens, the rods are practically alone. In the intermediate regions, both rods and cones are found.

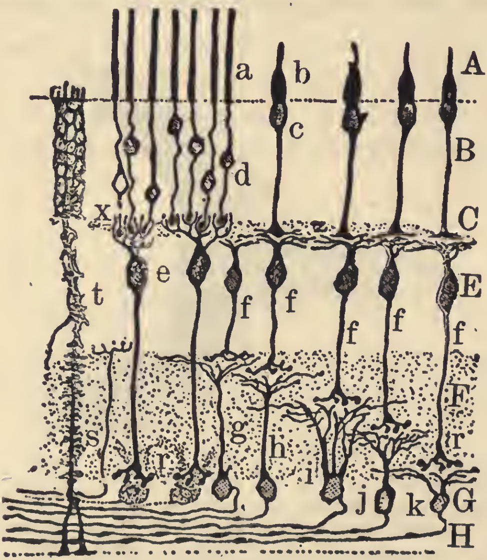


FIG. 26.—The layers of the retina. *A*, layer of rods and cones next the choroid; *a*, rods; *b*, cones. *E*, layer of large bipolar nerve cells; *G*, layer of large ganglion cells; *H*, layer of optic nerve fibers over which nervous impulses travel toward the brain after light has stimulated the rods and cones; *s*, a centrifugal nerve fiber permitting impulses to reach the retina from the brain. Unlike other sense organs, the retina is itself really a portion of the brain, pushed out to the periphery of the body.

In the very center of the region where the optic nerve enters the eye-ball there is no retinal structure, and in consequence no vision. This is the blind spot, whose presence can be easily verified by closing the left eye, fixating

the other upon a pencil point held some ten or twelve inches directly in front of the face while one moves a small object, like a coin, slowly to the right away from the pencil. When about three or four inches away from the point fixated, the object will suddenly disappear, a moment later to appear again.

The retina is sensitive to colors in a curiously irregular way. Under ordinary daylight conditions, only the central parts of the retina in and immediately about the fovea are capable of reporting all the colors to us. In most individuals the regions lying thirty or more degrees of arc away from the fovea are incapable of giving us sensations of red and green. These two colors, when they fall upon the outer margins of the retina, are seen as yellowish, bluish, or grayish, as the case may be. Then there comes a zone in which yellow and blue, and their compounds, together with white, black, and gray, are seen, and finally there is a narrow band in the extreme anterior part of the retina where all colors are seen as white, black, or gray, or not seen at all. Meantime, although these peripheral parts of the retina are relatively deficient in color vision, they are very sensitive to white light and to movement of any kind. Stars can often be seen in 'indirect vision' by these peripheral parts of the retina, where the rods predominate, which are invisible by direct foveal vision, where the cones are in charge.

Binocular Vision.—We have two eyes, and vision is a binocular process. Although under some conditions we see objects double, normally we have single vision, and we must say a word about the conditions which produce this result. Each eye is controlled by six muscles, by means of which it is moved right and left, and up and down. The

controlling muscles are so adjusted that the eyes always move upward or downward together. They may converge, that is, turn in, at the same time, but they may not diverge beyond the position at which their axes are parallel. The practical upshot of these limitations upon the movements of the eyes is that when the gaze is fixed upon a given

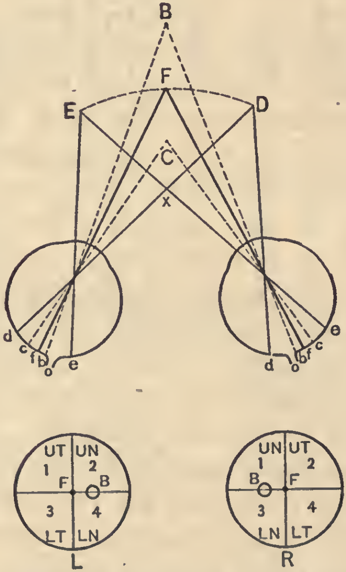


FIG. 27.—The two lower circles represent the retinal surfaces of the two eyes as seen from behind. *F* is the fovea, *B*, the blind spot where the optic nerve enters the eye. The retinæ are divided into four quadrants. Each quadrant corresponds to its geometrically (not anatomically) similar quadrant in the other eye, which bears the same number. The *nasal* half of one retina corresponds to the *temporal* half of the other. Corresponding points whose stimulation produces single vision are located in geometrically similar quadrants.

The upper part of the diagram represents the eyes fixated on the point *F* whose images fall on the two foveal regions *ff* and produce single vision. *O* is the optic nerve. Rays of light from such points as *E* and *D* fall on the corresponding points

point, the rays of light proceeding from it are brought to a focus upon the fovea of the two eyes, and the image of the entire object at which one is looking is distributed over each retina in such a way that *geometrically similar* regions are stimulated by rays from any given point. Single vision apparently results wherever this occurs. Figure 27 will illustrate the statement just made. If the retina of the right eye were lifted, moved across, and without rotation superposed upon the retina of the left eye, quadrant UN would be over quadrant UT, quadrant LT over quadrant LN, etc. A pin put through any part of any quadrant would then mark what are known as corresponding points, and these are points which when stimulated together normally produce single vision. The stimulation of other points produces either double vision or blurred vision. No doubt the fact that approximately one half of the fibers of the optic nerve of each eye cross over and join fiber tracts from the corresponding region of the

ee and *dd* and also produce single vision. Such a line as *EFD*, or it may be a surface, all of whose points are seen as single, is known as a horopter. When the eyes are fixated on *F*, points like *B* and *C*, which lie respectively behind and in front of *F*, are seen double. The rays proceeding from them will be found in non-corresponding quadrants of the retinæ at *bb* and *cc*. The rays from *B* fall at *b* and *b* which are both inside the foveal points, whereas *c* and *c* are both outside these points. The former produce 'homonomously,' the latter 'heteronomously,' doubled images.

If in the experiment suggested on page 86 an assistant pass a screen in front of one of the eyes, the double image on the same side as the screen will disappear when the nearer object is fixated. This is the case of a 'homonomous' image. The image on the side opposite to the screen (*i.e.*, heteronomous) will disappear when the farther object is fixated.

Such a figure as the prism *EXD* illustrates in an extreme form the facts of binocular stereoscopic vision. The right eye sees only the surface *XD*, the left eye only *EX*. The figure as seen by both eyes appears as a solid. Ordinarily there is a field common to both eyes as in looking at a sphere.

other eye on their way to the occipital cortex of the brain (Fig. 28) bears on this matter of single vision from corresponding points. If one holds up two pencils in the

FIG. 28.—Diagram of the optic pathway. *R*, the right eye, *L*, the left; *T*, T_1, *N*, N_1 the temporal and nasal halves respectively of the left and right retinæ; *TFL*, the *temporal field of view* of the left eye, seen by the *nasal half* of that eye; *NFR*, the *nasal field of view* of the right eye seen by the *temporal side* of the retina; *C*, the optic chiasma; *OFR*, optic fibers from the right half of each retina (i.e., right temporal, left nasal) passing through *LOC*, the lower visual centers in the geniculate bodies and the corpora quadrigemina, to *RO*, the occipital cortex of the right half of the cerebrum. *OFL*, fibers from the left halves of the two retinæ proceeding similarly to *LO*, the left side of the cerebral occipital cortex. Obviously destruction of one side of the visual cortex, or of the optic pathway anywhere above *C*, will produce blindness to one half of the field of view (hemianopsia) by destroying vision in one half of each retina. (Modified from Seguin.)

median plane of the face, one about four inches from the eyes and the other fifteen or twenty, it will be very easy by fixating the further pencil, to see the other one double.

Fixation of the nearer one will similarly produce doubling of the further one. In this case, the images of the doubled object are falling upon dissimilar regions of the two retinae.

Classification of Color Sensations.—Turning now to a more immediate analysis of the color qualities of vision, we remark at once that our optical sensations fall into two great natural groups, to-wit, those of the achromatic, or black-white-gray series, corresponding to mixed light waves, and those of the chromatic series, i.e., the spectral colors, from red to violet, corresponding to pure homogeneous waves.[1] Psychologists and painters have varied somewhat in their view regarding the number of so-called elementary colors. It was early observed that by taking a few primary colors, all the others could be produced through mixture, but one is by no means rigidly confined to one group of colors in selecting these 'primes.' Moreover, the results which one secures depend very largely on the methods chosen for making the mixtures. Yellow and blue, if mixed in certain pigments, produce green, whereas if they are mixed by reflection or by rotating disks, they produce gray.

Common language recognizes seven distinct shades in the

[1] A curious phenomenon sometimes made the basis of a classification of visual processes is found in the difference between 'twilight' and daylight vision. When the spectrum is viewed in full sunlight, the brightest region is in the yellow. When, however, by remaining for a time in the dark the retina has been adapted to very subdued lights, the green and the blue appear brighter than the yellow; and if the light is progressively made dimmer, the blue end of the spectrum can be discerned after the red end has disappeared. Seen in a faint light, therefore, the spectrum appears as a series of bands of gray with the brightest region in the green-blue zone.

sunlight spectrum, i.e., red, orange, yellow, green, light blue, indigo blue, and violet. Psychologists have generally maintained that there are only four genuinely different colors in the spectral group, to-wit, red, yellow, green, and blue. Orange is alleged to be an obvious compound of red and yellow. Violet is held to be similarly an obvious compound of blue and red. When one adds a little more red, one procures a shade of purple, and if the process be continued, the blue is finally altogether overcome, and we get back to red. Moreover, each of these spectral hues

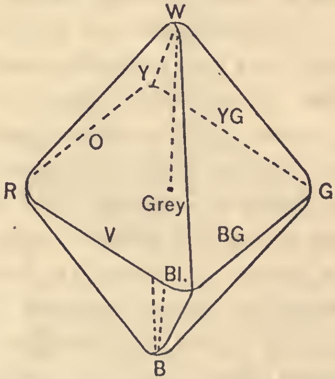


FIG. 29.—The color pyramid. The line *WB* corresponds to the white-black series of colors; the plane *Bl.RYG* represents the most saturated spectral colors, *e.g.*, blue, red, green. The lines joining *W* and *B* with the letters representing the several spectral colors, *e.g.*, *Bl.* represent all the transitional tints from blue through pale blue to white, and all the shades through the dark blues to black. (After Ebbinghaus.)

may be more or less 'saturated.' We can thus start with red and by adding more and more white produce a series of pinks, or by adding increasing amounts of black, we can produce a series of deepening browns. Figure 29 exhibits these relations. It will be recognized, too, that

colors vary in brightness as well as in saturation and chroma or hue.

Whatever view be taken regarding the number of the elementary spectral qualities, there are some very interesting relations among them which definitely affect our color vision, and to which brief reference may be made.

Color Mixtures.—When colored lights (not pigments)[1] are mixed together, new colors are produced in accordance with definite principles which can be formulated. For example, red and yellow will produce orange, blue and red will produce violet or purple, and all the combinations can be readily ascertained. One of the most interesting of these mixtures is that of the so-called *complementary colors,* which when combined produce gray. Every color in the spectrum has a complementary, also in the spectrum, except green. Yellow, if combined with blue, produces a whitish gray when pigmented papers rotated on a color wheel are used as the source of the colors. Red and blue-green similarly produce gray, but green must be combined with colors from the two ends of the spectrum, i.e., red and blue, or violet. Figure 30 exhibits these relationships graphically.

Color Contrast.—There are other color phenomena which also serve to show the intimate relations of these complementary colors to one another. Color contrast is one of these. If a patch of yellow be placed beside or upon a field of blue, and the eye be focused upon a point where the two join, it will presently be noticed that along the margin of junction the two colors are very much more brilliant and of deeper hue than elsewhere. The reason for this will be ex-

[1] Pigment mixtures produce different results. They depend on the effects of light absorption and can of course be formulated.

plained in a moment in connection with a brief account of after-images. Meantime, if instead of placing the yellow in immediate contact with blue, some other color, like red, or green, be selected, a different and less intense result is produced. The maximal effect of this kind is produced by complementary colors upon one another. This type of

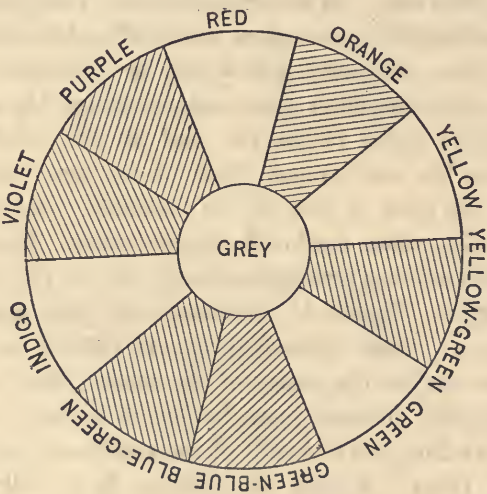


FIG. 30.—Colors at opposite ends of any diameter of the circle produce gray, if mixed with one another. Purple, which is the complementary color to green, is not found in the spectrum, but is produced by a mixture of the end-colors of the spectrum, red and violet. Colors opposite blank segments are alleged to be psychologically pure and elementary; *i.e.*, they do not suggest other colors. Some colors like orange distinctly suggest other hues, *e.g.*, in this case red and yellow. Colors opposite shaded segments are of this composite character.

contrast is sometimes spoken of as *successive contrast*, the eye passing from one color, which has been fixated, on to another. The visual quality of the latter is sure to be affected by the preceding retinal stimulation.

Simultaneous contrast is a name for a color phenomenon

less often observed in ordinary experience, but in some ways much more striking when encountered. If two small patches of the same gray paper be placed the one upon a blue field and the other upon a yellow field, the first will take on a yellowish, and the other a bluish tinge. If a thin piece of white tissue paper be spread over both colored surfaces, it will be quite impossible to convince any uninformed observer that the patches are actually pure gray, much less that they really match one another. This tendency of a colored surface to induce a *complementary* shade upon any small colorless area within its boundaries gives striking evidence again of the interdependence of complementary colors.

After-Images.—It is true in the case of all the senses that a stimulus exercises an effect upon the sense organ which somewhat outlasts its actual contact with the organ. Vision affords the most conspicuous instance of this fact in the so-called after-images, which ought, perhaps, rather to be called 'after-sensations.' These are of two main kinds, the positive and the negative. If the eye be closed for a few moments, and then opened and fixated for an instant upon an electric light, and at once closed again, there will be seen for some little time thereafter a distinct image of the light, and at first with an intensity only slightly less than that of the objective sensation. This is an example of the positive after-image. It takes its name from the photographic positive plate, in which the relations of light and shade and color are as in the object itself. The positive image is due simply to the continuation of the retinal excitement after the removal of the stimulus. The negative image involves a reversal of these light and color relations. If the eye be fixated upon a point in the

center of a small red field for fifteen or twenty seconds, and then turned upon some neutral colored field, or closed, there will presently emerge a bluish-green image corresponding to the red object originally fixated. In general it will be found that in the negative image all colors are complementaries of the colors in the stimulus, and the relations of light and shade will be inverted; what was light in the object will be dark in the after-image, and *vice versa*.

Color-Blindness.—Attention was called at an earlier point in the chapter to the fact that the peripheral portions of the normal retina are more or less color-blind. Some persons suffer from a form of color-blindness which affects the entire retina. This is a difficulty which seems much more common in men than in women. It is hardly practicable to describe pathological color-blindness in detail at this point. Suffice it to say that in one of the commoner types the spectrum is seen as half yellowish and half greenish. The region of the green itself is in these cases often seen as gray. Persons belonging to this group are said to be red-green blind. In general, it may be added that like the peripheral color-blindness of the normal eye, pathological color-blindness suggests that the color pairs red and green, blue and yellow, and black and white, respectively, belong together as more or less distinct parts of color vision.

Theory of Color Phenomena.—Many different theories of the color sense have been propounded, but there is as yet none which enjoys universal acceptance. In the writer's opinion, the theory of Mrs. Ladd-Franklin is preferable to any of the others at present available, because it presents fewer conflicts with recognized facts. It

may be said, indeed, that all the theories are simply attempts to formulate the several varieties of facts in a mutually consistent way.

Mrs. Franklin assumes that vision was originally confined to the qualities we now call gray, with white at one extreme and black at the other. The outer regions of the retina still represent this primitive condition. As evolution proceeded, the chemical substance in the retina which originally occasioned our sensations of gray has been differentiated so that it now is stimulated by the various spectral colors, each of which produces a partial disintegration of it. The first differentiation which occurred corresponds to the sensations of yellow and blue. It will be recalled that these colors are seen pretty well out toward the anterior regions of the retina. The last differentiation corresponds to the colors red and green, which are seen over a relatively circumscribed central region. This red and green process she thinks of as having developed out of the older yellow process. The explanations of the several forms of color phenomena resemble in many particulars those proposed by other theorists. We may formulate some of them very briefly.

Color mixture is brought about by the disintegration of one or another part of the chemical substance in the retina whose action directly stimulates the rods and cones. For example, when red and blue are combined, the result, i.e., purple, corresponds to a splitting off of the red part of the red-green process and a similar splitting off of the blue of the yellow-blue process. The gray of complementary colors is brought about by the entire disintegration of the original visual substance, just as occurs when white light itself is seen. If, for example, yellow and blue are mixed,

each color disintegrates a part of the original color substance. The two together effect a complete disintegration of it. After-images of the positive kind simply represent, as in all theories, the continuation of the original effects of the stimulus. Negative after-images are explained by assuming that after the eye has been stimulated for a considerable time by a color like blue, and one portion of the color molecules in consequence has been shattered, there is a tendency, after the blue is removed, for the rest of the molecular process to go to pieces in its turn. In this particular case the secondary part of the process represents yellow. Consequently the after-image for blue is yellow. Successive contrast is of course simply an after-image effect. If the eye has been fatigued for yellow, and is then turned to look at blue, the blue is seen as deeper and more vivid than otherwise, because there is a combination of actual *objective* blue with a negative *after-image* blue. Contrast phenomena are assigned to the progressive breaking down of the chemical substances, probably assisted by the capillary circulation. The gray patch in a yellow field is seen as bluish, because the molecules which the circulation carries across the retinal region corresponding to the gray are already disintegrated as regards yellow and are undergoing the process of disintegration which is seen as blue.

Auditory Sensations.—Psychologists have been wont to divide auditory sense experiences into two great groups—noises and tones. This is to be regarded as a convenient working division, rather than as implying any hard and fast distinction. It so happens that the sounds which we call tones arise from regular, periodic vibrations of the air, while noises arise from non-periodic vibrations.

Nevertheless, most tones have some accompaniments of noise, and many noises present a distinctly tonal character. The sounds of a piano are primarily tones, but the striking of the hammers upon the wires produces almost inevitably a noise which is heard with the tone. The rumble of cart wheels in the street is a noise, but at a little distance there is often a definite impression of tone. Certainly one notices the change in pitch as such a noisy vehicle disappears in the distance.

Pitch, Intensity, and Quality of Tones.—There is a relatively simple relation between our experiences of tone and the physical stimulations occasioning them. Thus the pitch of a tone corresponds to the frequency of the vibrations. We begin to hear these vibrations as tone when they occur at the rate of about sixteen or twenty to the second, and we cease to discern them as tones when they exceed forty or fifty thousand to the second. Most of our musical experiences are comprised within a relatively brief compass, running from about sixty-four vibrations in the second to some four or five thousand.

While pitch corresponds to the rate or frequency of vibration, the intensity of a tone corresponds to the amplitude of the vibration. The tone quality corresponds to the form of the sound wave, as determined by the number, character, and relative intensity of the partial tones which are present. German writers, in particular, speak of tones as *clangs,* and distinguish between simple and complex clangs. English writers sometimes speak of pure and mixed tones, or simple and complex tones. All these terms are designed to apply to the same set of facts, i.e., that a tone may arise from a vibration of a single rate, as in the case of a tuning fork, or from a group of vibrations made up

of a fundamental tone with a series of partial tones. In the case of a stretched string, for example, like a piano wire, or a violin string, there are vibrations corresponding not only to the entire length of the string, but also to segments of one-half, one-quarter, one-third, etc., of the length of the string. Each of these segments occasions a separate tone which blends with the others, and the quality of the entire mass of sound will depend upon the number of these partial tones, or over-tones, which are present, whether they harmonize or not with one another, and how strong each is in relation to the others. The peculiar tone quality of different instruments, e.g., the piano as contrasted with the cornet, or the flute, is entirely dependent upon this composition of the sound waves given off.

The ability to analyze complex tones, or chords, depends upon the capacity to pick out the constituent tones which enter into one of these complex tonal masses, and the ability to differentiate and identify familiar combinations of tones and noises depends on this same trait. The human voice is made up of both noises and tones, and spoken language illustrates this fact in the most precise way. The vowels are essentially tonal elements of speech. The consonants are intrinsically noises. Each individual voice represents a peculiar and characteristic combination of these two elements.

The Auditory Sense Organ.—Although the main facts and the general principles involved in the anatomy and physiology of the ear are quite capable of simple formulation, the minute anatomy is extremely complicated and difficult to follow. We can accordingly make no pretense of any such detailed exposition.

The ear consists of three main divisions (see Fig. 31);

(1) the external ear, of which the conch and part of the so-called meatus or passage is visible; (2) the middle ear, a wedge-shaped cavity with the broad edge of the wedge above, the sharp edge below, and the long axis roughly

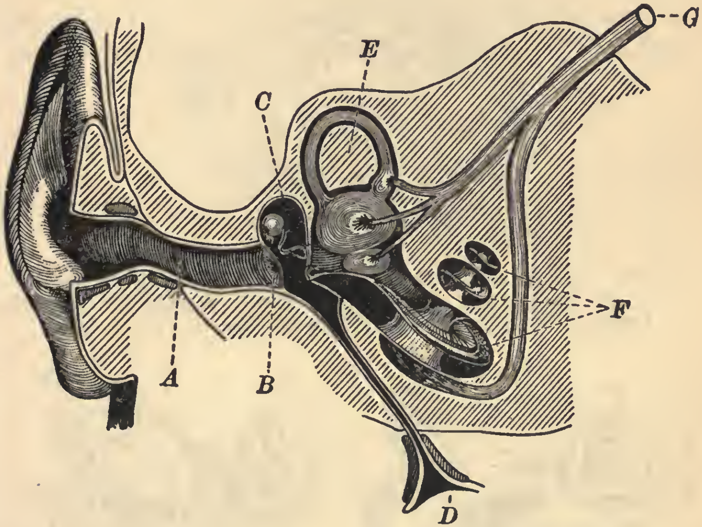


FIG. 31.—Diagram of ear. *A*, auditory canal of the external ear; *B*, tympanic membrane separating the external from the middle ear, *C*; *D*, Eustachian tube leading from the middle ear to the throat; *E*, one of the semicircular canals of the internal ear, arising out of the utricle upon which, as upon the adjacent saccule, fibers from the vestibular branch of the eighth nerve are shown terminating. The region of the internal ear opposite the end of the stirrup bone is known as the vestibule. *F*, the spiral of the cochlea, through the central pillar of which the auditory nerve is shown entering to spread out toward the hair cells of the cochlear canal, as indicated in Figures 32 and 35; *G*, the main trunk of the eighth nerve. (After Hough and Sedgwick.)

parallel with the sides of the head. From this a tube leads down into the throat. At the point where the external meatus opens into the middle ear a large membrane

fills up the passage. To the center of this membrane is attached the first of a chain of three bones extending from it across the cavity of the middle ear to an aperture in the inner surface of the chamber, which opens into (3)

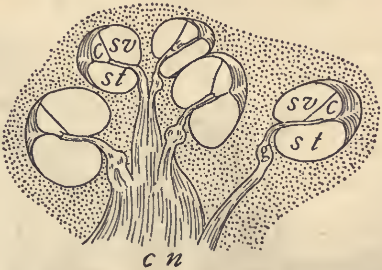


FIG. 32.—Vertical section through the bones containing the cochlea; *cn*, the main trunk of the cochlear nerve; *g*, ganglion; *st*, scala tympani; *sv*, scala vestibuli; *c*, cochlea canal. (After Gray.)

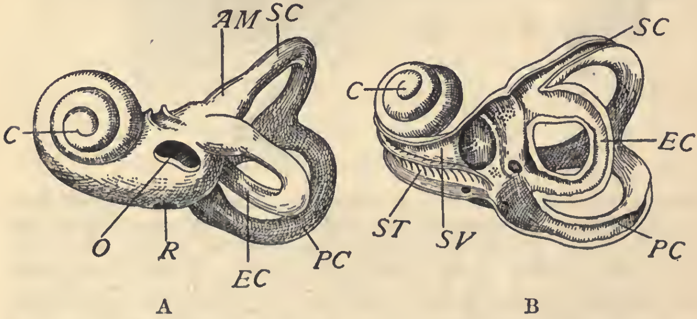


FIG. 33, *A* and *B*.—Sketch of left bony labyrinth viewed from outer side. In *B* part of the bones are cut away to show the internal cavities. *C*, cochlea; *SC*, superior semicircular canal; *EC*, external canal; *PC*, posterior canal; *AM*, ampulla of canal; *O*, oval window into which stirrup bone fits; *R*, round window opening into the middle ear; *ST*, scale tympani, connected with *R*; *SV*, scala vestibuli, connected with *O*. (After Cunningham.)

the internal ear. This last is a very elaborate system of tunnels or cavities in the solid bone of the skull, lined throughout with an extremely irregular membranous sac,

filled with fluids and supported upon appropriate bony structures. Inside the sac are mounted innumerable little hair cells, whose bases are in connection with the minute terminations of the sensory nerve. See Figs. 32, 33, 34, 35.

When a sound wave reaches the ear, it first throws into vibration the drum membrane separating the external from the middle ear. Attached to the center of this membrane is the first of the chain of bones, whose motion is in turn transmitted to the other two bones in the chain, and thence by the impact of the latter upon the liquid (found both outside and inside the membranous sac) of the internal ear, vibrations are set up which stimulate the tiny hairs of the hair cells. *At this point* originate the nervous impulses which, traveling back up the auditory nerve, finally reach the auditory cortex of the cerebrum (see Fig. 13), whereupon a sound is heard.

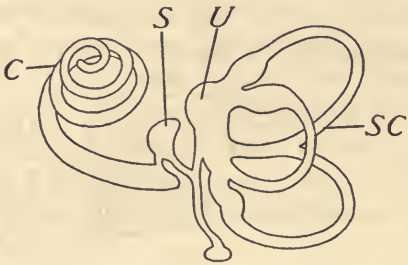


FIG. 34.—Diagram of membranous labyrinth [supported within the bony labyrinth shown in Figure 33], filled with lymph and surrounded by it. *C*, cochlea; *S*, saccule, united by a small duct, with *U*, the utricle, out of which spring the semicircular canals, *SC*. The connection of the nerve with the end organs in the membranous labyrinth is indicated in Figure 31. (After Cunningham.)

The Semicircular Canals.—The vestibular portions of the internal ear (see Figs. 31, 34) may possibly have to do

with the perception of noise, though this is very doubtful, but the semicircular canals are organs for the detection of bodily movement and for the preservation of balance. They have no real auditory function at all. In the primitive ear we find a rude sac with little pebble-like otoliths which, when the organism is moved or jarred, strike against the sensitive walls of the sac and so give a sensory warning signal. In man and the higher animals this organ has differentiated into two—the one the cochlear structure we have described, sensitive primarily to air vibrations outside

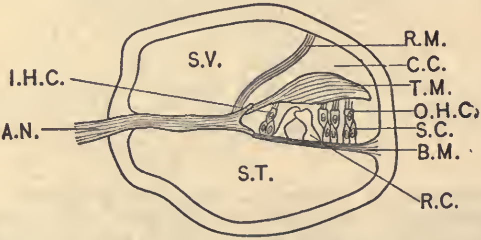


FIG. 35.—Diagram of a cross section of one of the whorls of the cochlea. *S.T.*, scala tympani, a lymph-filled passage leading from a round window, closed by a membrane, in the wall of the middle ear. This membrane permits some movement to and fro of the liquids of the internal ear, when vibrations are set up in them by the air waves coming in through the external and middle ear. *S.V.*, scala vestibuli, a channel leading from the oval window in the wall of the middle ear into which the base of the stirrup bone is inserted. These two passages, *S.T.* and *S.V.*, join one another at the top of the cochlea. *C.C.*, the lymph-filled canal of the cochlea, separated by *R.M.*, Reissner's membrane, from the scala vestibuli and by *B.M.*, the basilar membrane, from the scala tympani. *T.M.*, the tectorial membrane thought by some authorities to be the body which responds by sympathetic vibrations to the waves produced in the endolymph of the ear by external sounds. The theory assumes that the membrane strikes against the tips of the hair cells and thus sets up nervous impulses in the auditory nerve. Most authorities think that the basilar membrane serves this function and transmits its vibrations directly to the hair cells resting on it. *I.H.C.* and *O.H.C.*, inner and outer rows of hair cells respectively; *S.C.*, supporting cells; *R.C.*, rods of Corti; *A.N.*, auditory nerve. (Modified from Stewart.)

the organism; the other the semicircular canals and the vestibular apparatus, sensitive to gross movements of the entire body. The three canals have developed approximately at right angles to each other and corresponding to the three main planes of the body. Each is presumably most sensitive to movement of the body in one of these planes. Like the vestibular arrangement, they retain the old otolith device. These otoliths are suspended in the liquids of the membranous sac and when the head or body is moved quickly, they lag somewhat behind and come into contact with the hair cell terminals found in these regions, as well as in the cochlea. This sets up a sensory impulse, which, instead of passing to the auditory cortex and so occasioning a sensation of sound, is conveyed over quite a different pathway to cerebellar and other centers and thence to certain muscle groups—of the eyes, the head, and trunk—and compensatory movements are released tending to preserve bodily equilibrium.

It is doubtful whether under normal conditions the semicircular canals produce any sensations of which we are directly conscious. But if they be violently stimulated, as in rapid whirling, we are made dizzy. We thus learn of their action through the sensations of vision and contact and movement, which they reflexly stimulate, rather than directly by a conscious quality of their own. There is no question of their practical importance, for if diseased, they cause dizziness, loss of balance, and general disturbance of motor coördination.

Gustatory Sensations.—As the result of a good deal of discussion and experimentation, psychologists have come generally to agree that there are four, and only four, elementary qualities of taste, i.e., salt, sour, sweet, and bitter.

Some observers would add to this list metallic and soapy tastes. They are often combined with one another and with sensations of temperature, contact, smell, and movement. By means of such combinations we have a very large number of characteristic tastes of foods and beverages which are, however, capable of analysis into these constituents. Lemonade in its ordinary forms obviously involves sour, sweet, cold, and contact. Coffee involves bitter, sweet, heat, and contact. Both involve odor to a degree that the uninformed person is utterly unaware of. Everybody has observed that when suffering from a cold in the head the tastes of foods are apt to be dulled. This is commonly attributed to the direct effect of inflammation and congestion of the membranes of the mouth. In point of fact it is much more largely due to the suppression of sensations of smell. By blindfolding the eyes and stopping the nostrils, it will be found that the average individual is quite at a loss to identify many of the common food substances, and if the further precaution be taken of reducing them to fluid form and presenting them at the temperature of the mouth, it will be found that only the four qualities already mentioned can as a rule be detected, and even for them there is often great uncertainty.

There are several kinds of evidence tending to confirm the really elementary character of these four tastes. One of them is indicated in the suggestion above. If the stimuli are all made of uniform temperature, and reduced to fluid form with the elimination of smell, there is almost never a tendency to mention any other kind of taste quality. These four seem to every observer adequate.

It is commonly supposed that the various taste sensations may be experienced on any part of the tongue. As a

matter of fact, the center of the tongue is very little sensitive to taste, and the marginal regions differ decidedly from one another in the kind of sensitivity possessed. (Fig. 36.) Thus the tip of the tongue is peculiarly sensitive to sweet and salt, the sides to sour, and the base to bitter. It is a curious fact, suggesting the existence of special receptors for the different kinds of sense qualities,

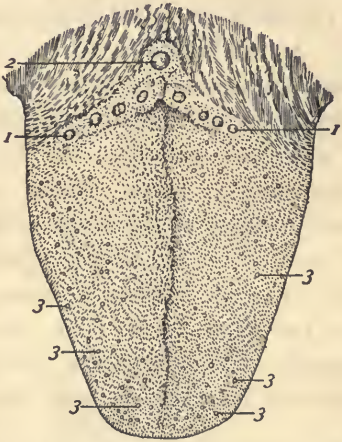


FIG. 36.—Surface of tongue seen from above. The taste buds in which the gustatory nerves terminate lie mainly in the walls of 1 and 2, the circumvallate papillæ, and 3, the fungiform papillæ. (After Schäfer.)

that some substances produce a very different taste upon different parts of the tongue. At the tip, saccharine is extremely sweet, at the base it tastes bitter. There are some indications also of interrelations of an intimate kind between the elementary qualities. Thus there are drugs which if applied to the surface of the tongue will paralyze the sensitivity for bitter and sweet without affecting the other tastes.

The Gustatory Sense Organ.—In order that a substance may be tasted at all, it must be presented in liquid form, and no solid, if taken into the mouth, can be tasted unless it is soluble by the saliva. The reason for this seems easy to understand when it is remembered that the receptors for taste stimuli terminate at the base of very minute cell structures shown in Figs. 37, 38, 39, which lie imbedded in deep crevices in the walls of certain papillae. Direct contact with these organs is thus rendered quite impossible except for a fluid. As has been pointed out in the preceding paragraph, these papillae, whose form differs considerably in different regions of the tongue, are distributed over the sides, tip, and base, the center of the tongue being substantially destitute of them. There are some taste nerves occasionally found in the cheeks and in the neighborhood of the palate. Attention has already been called to the fact that what we commonly designate taste is in point of fact a fusion of smell, taste, temperature, contact, and movement. The tongue is very richly innervated with receptors for contact, pain, temperature, and movement.

Olfactory Sensations.—Sensations of smell are, as we have noticed, intimately connected with those of taste. This connection is undoubtedly very ancient and represents the fundamental importance of these two senses as guardians of the food supplies in primitive animal conditions. Despite this intimate connection, smell presents some very striking contrasts to taste. The taste qualities are few in number and relatively easy to isolate. Smell, on the other hand, presents an almost endless complexity of qualities, which can at best be grouped together in certain roughly separable classes. The taste qualities appear

to be connected in a general way with anatomically distinct regions. Smell, so far as can be detected, offers no

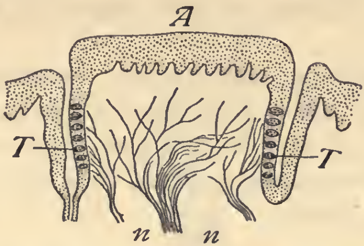


FIG. 37.—Vertical section of circumvallate papilla of a calf. *A*, the papilla; *n*, the gustatory nerve fibrils terminating in and about *T*, the taste buds. (After Engelmann.)

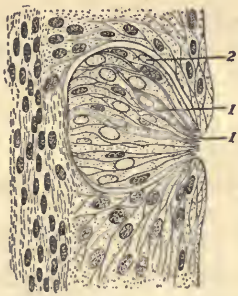


FIG. 38.—Vertical section through a taste bud. 1, gustatory cells with hair-like terminals; 2, supporting cells. (After Cunningham.)

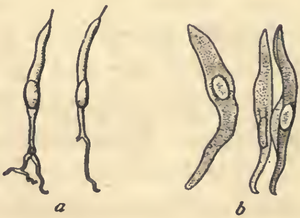


FIG. 39.—Diagram of the cells found in a taste bud. *a*, gustatory cells; *b*, supporting cells. (After Cunningham.)

topographical differentiation. The stimulus to taste must be a fluid. The stimulus to smell must be a gas, or at all events, finely divided particles suspended in a gas such as the air.

The accompanying table contains the grouping of smell qualities which is now most generally employed as a working division. It is a modification made by the Dutch physiologist Zwaardemaker of an older table proposed by the botanist Linnaeus.

1—Ethereal smells, including fruit odors.
2—Aromatic smells, e.g., camphor, spice.
3—Fragrant smells, e.g., such flowers as violets and sweet peas.
4—Ambrosiac smells, e.g., musk.
5—Alliaceous smells, e.g., garlic, chlorine.
6—Empyreumatic smells, e.g., burning tobacco, burnt toast.
7—Hircine smells, e.g., cheese.
8—Virulent smells, e.g., opium.
9—Nauseous smells, e.g., decaying animal matter.

The difficulty of grouping odors or of reducing them to a small number of elementary types is suggested by the fact that the ordinary method of designating them involves either a reference to the names of the objects from which they come (e.g., lemon odor, the odor of roses, etc.) or characterizing them by adjectives borrowed from taste, as when we speak of a sweet odor or a sour odor, or finally, grouping them as agreeable or disagreeable.

Olfactory Sense Organ.—Receptors for smell terminate about the bases of little hair-like or thread-like cells imbedded in the mucous membrane of the upper portion of the nasal cavity. (Fig. 40.) Unlike most sensory terminal organs these cells are apparently themselves true nerv-

ous tissue. The general location of this olfactory membrane may be seen in Figure 41. This figure shows graphically how in gentle breathing the air currents may pass

FIG. 40.—Isolated cells from olfactory region of the rabbit; *st*, supporting cells; *s*, short, stiff cilia, or, according to some authorities, cones of mucus resembling cilia; *r*, *r*, olfactory cells. (McKendrick and Snodgrass after Stöhr.)

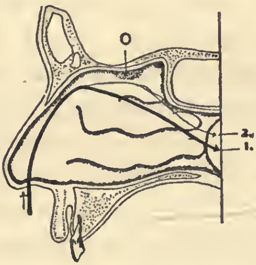


FIG. 41.—Diagram to show the location of the olfactory end-organs and the course of the air currents when we breathe. *O*, the olfactory membrane of the right nostril into which the olfactory nerve comes down through the bone above. The black line, numbered 1, indicates the usual course of the air in natural breathing. The lighter line, numbered 2, indicates the course of the air when we inhale strongly. (Modified from Zwaardemaker.)

up through the nostrils and into the lungs without coming into violent contact with this olfactory region. In vigorous inhalation, on the other hand, the currents of air are

drawn up sharply against the membrane and we secure vivid and distinct sensations.

As in the case of taste, but to a less degree, there is uncertainty regarding the exact cortical terminations of the smell nerves, but the best modern knowledge is embodied in Figure 14, opposite page 36.

Cutaneous Sensations.—It is usual to speak as though the skin were itself a sensitive organ, and it is of course true that we feel the various kinds of stimuli which come in contact with it. But in strictness, the skin is simply a protective covering within whose deeper layers the real receptors are imbedded. By common consent, pressure, heat, cold, and pain are mediated by skin sensations. Ordinarily two or more of these are aroused together by the usual forms of stimulation, and as a matter of fact there are generally added the kinaesthetic sensations arising from muscular movement. Thus, if I reach out my hand and grasp the book lying upon the table, I obtain sensations of contact, of temperature, and of movement. If I burn myself, I secure simultaneously sensations of heat and pain.

Contrary to the usual impression, these various forms of sensitivity are not distributed evenly over the entire bodily surface. The skin presents a sort of mosaic, with points sensitive to one kind of stimulation interspersed between points sensitive to other forms, and with adjacent points insensitive to all kinds of stimuli. Of course if a stimulus be made sufficiently intense, almost any region will respond. Nevertheless, the statement just made is essentially true. (See Fig. 42.)

If a blunt metal point, even a pencil point, be cooled and then be gently passed over the skin of the back of the

hand, there will be spots where a perfectly distinct flash of cold will be felt, and other spots on which either contact alone or nothing at all will be sensed. A similar result will be encountered if the point be slightly heated. Warmth will be clearly sensed now and then, but will be found quite lacking at other points. The spots sensitive to pressure are more numerous than those sensitive to warmth and cold of moderate degree. More numerous than either are the spots sensitive to painful pressure,

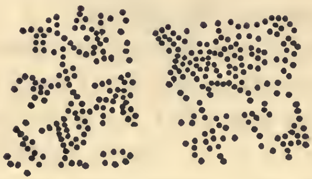


FIG. 42.—*C*, cold spots; *H*, hot spots from an area on the back of the wrist. Similar spots sensitive to pressure and to pain respectively have been charted. (McKendrick and Snodgrass after Goldscheider.)

like that of a needle. There are some regions, like the cornea of the eye, on which practically only pain sensations can be aroused. Oddly enough, there are some regions which seem quite insensitive to pain from puncture. There is a region of this kind on the inner surface of the cheek. The sensitivity differs very widely on various surfaces, as is illustrated, in the case of contact or pressure, by the tip of the tongue, the tip of the fingers, and the skin just above the elbow. The first two surfaces are sensitive to differences much more minute than those which can be sensed by the last mentioned region. A simple demonstration may be made by lightly touching

three such regions with a pair of compass points set a quarter of an inch apart. A similar type of disparity characterizes the distribution of sensitivity in the case of the other skin senses.

Cutaneous Sense Organs.—Although the evidence is not as yet absolutely conclusive, there is strong reason to believe that the receptors for the different kinds of sensation mentioned have each a different type of terminal organ. Figure 43 exhibits the different terminals now plausibly regarded as the receiving devices for the different kinds of cutaneous stimulations.

The cortical receiving stations for these various sensations [with the possible exception of pain, which is perhaps represented in the thalamus] are pretty well localized, as shown in Figure 13, in the region posterior to the fissure of Rolando. The close proximity to the great motor zone (an arrangement suggestive of that in the spinal cord) must not be overlooked, and will not be thought strange when one remembers that these cutaneous experiences are probably the most primitive and ancient of organic life. Behavior in its earliest forms was in considerable measure simply motor adjustment in response to stimulations of the cutaneous type.

Kinaesthetic Sensations.—We have frequently had occasion to refer to sensations of movement. Psychologists generally refer to these as kinaesthetic. There has been little successful effort to analyze them, and isolation is particularly difficult because they occur almost without exception in conjunction with other kinds of sensation. Various illustrations have been given from time to time of these combined kinaesthetic and cutaneous sensations. When one moves the hand, there is almost inevitably a

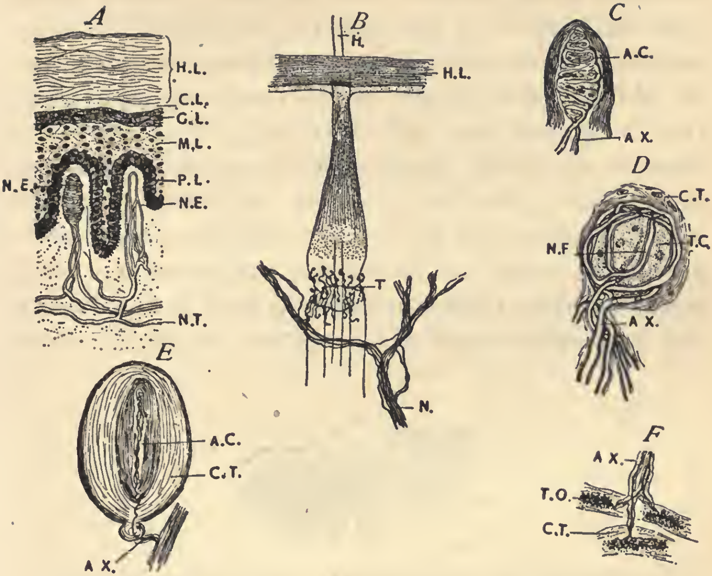


FIG. 43.—*A*, diagrammatic cross section of the skin showing *H.L.*, the horny layer or epidermis, *C.L.*, the clear layer, *G.L.*, the granular layer, *M.L.*, the mucous layer, *P.L.*, the papillary layer, forming the outer border of the dermis; *N.E.*, nerve endings, and *N.T.*, the trunks of the nerves. *B*, diagrammatic cross section of the skin showing a hair and the nerve winding about its base; *H.*, the hair; *H.L.*, horny layer of the epidermis; *N.*, nerve trunk, mediating contact sensations, with terminals, *T.*, about the base of the hair. *C*, a tactile corpuscle of Meissner. *AX.*, the axonic processes wrapping about the tissue of the corpuscle. *A.C.*, naked axis cylinders. *D*, end-bulb of Krause, possibly organ of sensations of cold. *AX.*, axones entering the bulb; *N.F.*, naked axone fibers; *T.C.*, so-called touch cells; *C.T.*, connective tissue of the skin. *E*, Pacinian corpuscle, probably concerned in contact sensations; *AX.*, axone entering the corpuscle with axis cylinder terminations at *A.C.; C.T.*, connective tissue. *F*, Ruffini's nerve endings, possibly mediating warmth sensations; *AX.*, axones; *T.O.*, terminal organs; *C.T.*, connective tissue. The free nerve endings, thought to mediate pain sensations, have no terminal organ; the fibers simply thin out to a point, or blunt end, and stop. (Modified from Cunningham, Retzius and Toldt.)

stretching of the skin so as to produce a pressure sensation, which tends to fuse with the kinaesthetic or motor sensations, thus confusing, or at least obscuring, somewhat the characteristic quality of the motor sensation itself. It is the general view today that these kinaesthetic sensations are due to the stimulation of receptors which terminate in the muscle surfaces, or in the insertions of tendons and ligaments, or in the cartilaginous surfaces of joints. Obviously, under ordinary conditions the sensations from these three sources would tend to fuse because they practically always occur together. However difficult

FIG. 44.—Termination of sensory nerve in a tendon; *AX.*, axone; *T.*, tendon; *T.O.*, terminal organs. (Modified from Morris.)

of isolation and analysis, there can be no doubt that the sensations of this group play an extremely important part in our control over our movements. But of this more will be said at a later point.

Kinaesthetic Sense Organs.—Figure 44 illustrates the type of terminal organ for the kinaesthetic receptors. The central receiving station in the cortex is by clinicians located in the post-Rolandic region along with the cutaneous group of sensations.

Organic Sensations.—One group of sensory experiences remains to be described. These are designated in a general way organic sensations. To this group strictly considered should be assigned the kinaesthetic sensations,

because like the general class of organic sensations, they are caused by changes occurring *inside* of the organism. It is convenient, however, to distinguish the kinaesthetic group from the others, despite this common property of intra-organic origin. Ordinarily sensations of touch, taste, smell, vision, and hearing are aroused by objects *outside* the body.

Illustrations of these organic sensations are such experiences as arise from respiration and circulation. The consciousness of feeling choked or stifled when the air is close is an instance of this kind. The congestion of the head when one is ill affords another example. Hunger, thirst, and nausea, are still other instances. Dizziness mentioned in connection with the semicircular canal functions is sometimes included. The list is a rather long one, and need not be given in detail here. The reader can doubtless supply many other illustrations.

Receptors for Organic Sensations.—The receptors for some of these experiences are not well identified, but in general they no doubt belong to the cutaneous and kinaesthetic type. In many of them pain is represented, and in these cases presumably the receptor is similar to that already described for painful cutaneous experiences. The cortical receiving stations are also problematical, except in so far as the sensations are identifiable with those of kinaesthesis and the cutaneous sensation group.

CHAPTER VII

SENSE PERCEPTION

Sensation and Perception.—Throughout the previous chapter, we have discussed the adjustive sensory processes with regard to the different kinds of stimuli which arouse them, the different qualities of sensation which are called forth, and the peculiar structure of the sense organs and nerves upon which they depend. Psychologists often speak of sensations as mental *elements,* because they are apparently simple qualities which resist further analysis, just as do oxygen and the other chemical elements. Sensations are supposed to combine with other kinds of mental elements called simple feelings, to be mentioned later, to produce mental compounds such as we shall deal with from this point on.

We now pass to another phase of these sensory activities, which psychologists commonly call perception, defined by James as "the consciousness of particular material *objects* present to sense." While it is true that these objects seem in a certain sense to be simple combinations of sense qualities, nevertheless what we see when we open our eyes is not the mere color quality green, but green *leaves,* green *grass,* and other green *objects.* Similarly, when we hear sounds, our immediate perception is of a street car, or of a locomotive whistle, or of a class bell. Each of these sounds has its own peculiar sensation quality as noise or tone, but the immediate reaction upon hearing any one of them involves our identification of the sound in the

manner mentioned. The perception conveys *meaning* to us. It involves our apprehension of some at least of the *relations* sustained by the object to other objects, e.g., its direction, distance, etc. The other senses will all illustrate the same thing. We perceive a book in part by the impressions of contact and temperature which come from the hand as we grasp it. We perceive a violet by its odor, even though we cannot see it. However meager the sensory data with which we are supplied, in each case we tend to perceive an *object* with a more or less definite fringe of relations. It is, then, to an analysis of certain features of these perceptual operations that we must next proceed.

As contrasted with sensation, in the psychologist's meaning of the term as the *consciousness of sensory quality,* perception is relatively more real and more concrete. To get at a sensation of color involves our abstracting it from the general complex in which it is imbedded. The color of a ribbon may thus be considered apart from the special texture of the fabric in which it appears and apart from the other colors surrounding it. We can only direct attention to the color itself by thus disregarding all the other accompanying circumstances. In perception we have a mental state in which we apprehend a group of sensory qualities as an *object,* in this case the ribbon. To be sure, as was pointed out when discussing attention, the very process by which we perceive one object involves our disregarding more or less all other objects. Even here, then, there is a certain sort of abstraction and isolation. But from the common-sense point of view sense perception gives us the real objects of daily life, the tables and chairs, cats and dogs, sticks and stones of every-day experience.

Organization of Sensations in Perception.—As an adjustive process, perception represents very distinctly an *organization* of *sensations* into *units* such that we can make *practical motor responses* to them. An apple, as a mere matter of sensation, appeals to touch, sight, smell, and taste, to mention no other possibilities. As a perception all these qualities are centered in the object to which by extending the hand we can make an effective and satisfactory response. As compared with animals, human beings undoubtedly make far less use of smell, and probably much less of taste, as guides to their larger bodily reactions. Vision, hearing, and contact afford the predominant foci of human perceptions.

Part Played in Perception by Previous Experience.—We saw in an earlier chapter that constant modification is taking place in our reactions by virtue of our ability to carry over from one moment to the next that which we have learned. This fact is perfectly obvious in all the instances of gross general behavior, such as the learning of a new motor habit like skating. The same principle applies, however, to perception as to all other conscious processes. To the plain man it seems obvious that what he perceives when he looks across the room and sees a square-topped table is simply that which is before his eyes. As a matter of fact what he perceives is in no sense merely that which is physically present to his retinae, but a much more complex object and one which in certain particulars differs essentially from that presented to his eyes. To take but a single feature of the situation: if he be standing across the room, as assumed in the illustration, the table top which he sees as square,—that is, with four right angles and equal sides—is projected on his retinae as a

figure with two obtuse and two acute angles. If he really saw simply what is optically before him, he would perceive a figure of the rhomboid type, and not a square at all. The truth of this statement becomes apparent the moment one tries to draw a table as seen from such a position. If one uses actual right angles in the sketch, the drawing will be a failure. Moreover, when one looks at a polished wood or metal surface, as in a case like that of our illustration, one gets something of the feelings of smoothness, coolness, and hardness, all of which are tactual qualities that somehow fuse with the visual impression. A perception may thus involve sensory qualities belonging to other sense organs than that directly stimulated at the moment.

It is sometimes said that we see what we expect to see, or what we are accustomed to see, and this is true in a much more intimate and thorough-going way than is ordinarily appreciated. We tend to interpret every sensory stimulus, like the table top, in terms of our previous experience of similar objects, and for the most part we assume that that sort of perception which is most consistent with all our experiences of the object in question presents its 'true' or 'real' form. Language is a particularly striking instance of the effects of experience upon our perceiving. The words of a strange language may strike upon the ear in absolutely the same fashion in which they do at a later period after the language has been mastered. The *sensations* elicited in the two cases may really be to all intents and purposes identical; but the perceptions are radically different. In the first instance we hear simply a mélange of meaningless sound; in the second, experience furnishes a whole host of interpretative meanings which are entirely missing in the first case. What

we perceive at any given moment is quite as much determined by our momentary interests, by our past experience and the modifications which it has impressed upon the nervous system, as by the particular object physically present to our senses.

Perception and Illusion.—Certain illusions, which are simply erroneous perceptions, furnish additional evidence of the dependence of perception upon preceding experience.[1] The figure (45) sketched on this page, like that on

FIG. 45.—(After Gordon.)

[1] Illusions may be roughly grouped as arising (1) from habits, (2) from expectancy, and (3) from sense organ structure. (1) We perceive a rumbling noise as a distant train because that is a *common* source of such a sound. In the present case it may be thunder. (2) We waken in the night, fear burglars and distinctly hear footsteps—which are as a matter of fact simply the sounds of the creaking of boards caused by wind or change of temperature. (3) Figure 47, page 127, exhibits illusions which belong at least in part to this group.

Like illusions, hallucinations are false perceptions, but in this case apparently no external physical stimulus is present. They may be due to derangements in the sense organs or in the cerebral cortex. They are common in certain forms of insanity and may involve any of the senses.

page 60, may be seen in at least three different ways. The figure may be perceived as a pile of cubes with black surfaces uppermost, or as a cornice which one is looking at from below, or finally—though this is difficult to observe for more than an instant—as a flat mosaic of black, white, and gray diamonds. The reader will note that in each case the retinal stimulus is absolutely identical, and yet three quite distinct objects are perceived. Clearly this result can only be explained by the fact that one's previous experience affords the three different contexts for one and the same set of lines. Which particular group shall be brought into action at any one moment is evidently more or less accidental. Typographical errors are overlooked by the ordinary reader unless they are very serious, because he sees what he is in the habit of seeing, and not what is really before him. Thus the error in the phrase 'Pacific Ocəan' will by many readers be entirely unnoticed.

The extent to which these perceptual reactions acquire meaning from previous experience should make it clear that the organization of sensation which is represented, is in large measure embodied in the cortical neurones. To perceive a couple of dozen lines as a pyramid of cubes involves the arousal in an organized and systematic fashion of large groups of cerebral neurones, and it is evident that the type of motor reaction appropriate to dealing with the pyramid experience would be decidedly different from that required by the cornice experience. The organization, therefore, of our sensations exhibited in perception is reflected in a corresponding organization of motor response. The two things go together. Both are subject to the general principle of habit, which we discussed rather fully in Chapter IV.

Perception of Time and Space.—Perception not only gives us our contact with the physical world of objects, but it is also the channel through which we gain our knowledge of space and time. It is sometimes said that all our perceptions come to us imbedded in time and most of them in space. Our common phrases suggest that we perceive both time and space just as we perceive objects. Philosophy has from the earliest times busied itself with the attempt to understand the ultimate nature of these two forms of experience. We must try to steer clear of the more metaphysical aspects of the problem, but we can hardly forego some slight study of the psychology of the processes. Our adjustments to our surroundings occur in a medium of both time and space, and the effectiveness of our reactions is largely conditioned by our ability to make intelligent allowance for these factors.

Space Perception and the Several Senses.—There has been some controversy among psychologists as to whether all of our senses are capable of mediating experiences of space. Vision, touch, and the kinaesthetic sensations have generally been accepted as self-evident sources of space perception. The other senses, and particularly hearing, have been the chief centers of discussion. William James, for example, was wont to maintain that all sensory experience is 'voluminous.' He held that certain sounds are massive, and others thin and fragile. Similarly, he maintained that some odors are big and expansive as compared with others. Taste is hardly a profitable source of discussion, because it is compromised by its connection with contact and temperature. The precise meaning of the controversy can perhaps be better understood after we have

analyzed some of the conspicuous features in the perception of space.

In animal life, and particularly in its lower stages, the adjustment to space relations hinges very largely upon the factor of direction. The creature needs to go in the general direction of its food supply and needs to retreat from locations where its enemies are found. Another important capacity, from which the sense of direction has perhaps developed, is the ability to localize stimulations upon the bodily surfaces. Behavior of this type, as when a frog lifts one of its legs to wipe off an injurious substance from its body, obviously involves a form of spacial adjustment. The perception of distance and the perception of shape and size are presumably somewhat later acquirements, although many of the lower animals seem to have a relatively accurate ability to estimate distances near at hand.

If we consider first the capacity to detect direction, it is fairly clear that vision, touch, movement, hearing, and smell may all serve us with varying degrees of accuracy, and that possibly taste would also be found in this group if it could be separated from touch. If we are to make the detection of direction our criterion, we can hardly deny spacial character to any of our sensations, at least not if we permit the coöperation of movement. But when we turn to the other factors mentioned we find ourselves led to quite a different conclusion.

Visual objects clearly have shape and size, and these qualities we perceive quite as truly as we perceive the objects possessing them. Indeed, in a sense they are one and the same. But who would ever think of the possibility of perceiving a square sound, or a round odor?

Certain psychologists maintain, to be sure, as we have already implied, that some sounds are larger than others, some odors more voluminous. Thus the sound of a bass drum is alleged to be bigger than the shrill whistle of a fife, and the odors of garlic, onions, and illuminating gas are thought of as more pervasive, more space-occupying than the odors of violets, sandalwood, and lemons.

There are certain obvious sources of possible confusion in such supposed evidence as has just been advanced. In the case of the bass drum, there is to be mentioned the intensity of the sound, which has as one of its results a more or less general bodily jarring which naturally conveys an impression of bigness. Associated with this is often our knowledge of the majestic proportions of the instrument from which the noise proceeds. One or both of these factors are likely to affect our impressions of the volume of the sound. But even admitting the strong suggestion of spacial character which the sound brings us, no one would undertake to describe the shape of such sounds, or to estimate their exact size with reference to other sounds. One sound may be louder than another, that is, more intense, and we often venture to estimate the relative intensity of such sounds, but measures of their size and shape one never undertakes.

Exactly the same kind of consideration may be urged about odors. Undoubtedly we find them suggestive of spacial qualities, and we certainly localize them more or less accurately. But the complete list of spacial characteristics, including size and shape, which are so clearly features of the visual-touch-movement space experiences, are certainly lacking. We can hardly, then, deny to them whatever of space character belongs to the ability to dis-

cern direction, but we can certainly not attribute to them the full quota of space properties.

We must now turn back to examine in more detail the important peculiarities of the several senses as media of space perception.

Space Perception from Smell.—Apart from its vague suggestion of space relations, to which we have already referred, human beings secure through smell only very crude impressions of direction. If we wish to identify the direction from which an odor is coming, it is almost essential that we should turn the head in this direction and that until we have determined at what point the odor is most intense. Whether the human sense of smell has suffered atrophy or not in the evolution from our animal ancestry, there can be no question that at the present time many animals excel us hopelessly in the accuracy and delicacy with which they make use of this sense.

Auditory Space Perception.—In even greater degree, perhaps, than smell, hearing conveys suggestions of many kinds of space relations, but its only unequivocal spacial function is the determination of direction, in which it is distinctly superior. Within certain limits, to be described, we can localize sound promptly and with a measure of accuracy. This capacity is dependent in largest part on the fact that we have two ears and that sounds often come to us in such a way as to stimulate one ear more strongly than the other. This is obviously true of all sounds except those in the median vertical plane of the body at right angles to the line joining the ears. In this plane localization is extremely inaccurate, and with closed eyes an inexperienced person is generally quite unable to determine whether sounds are in front of, or behind, the

head, and whether they are high up or low down. On the other hand, sounds originating from points on either side of this plane and a few degrees outside of it are localized instantly and with great confidence as to the side from which they come; but it is often extremely difficult, without the assistance of vision, or without movement of the head, to determine whether the sound is somewhat in front of, or somewhat behind, the line joining the ears.

The ease or difficulty of these localizations is related in part to the character of the sound itself. While with normal individuals there is never any difficulty in determining from which side a sound comes, the accuracy of the localization as regards the more exact position is far higher with noises and with complex tones than it is with simple tones, like those of a tuning fork. The reason for this seems to be that the overtones of noises and complex tones are so affected by the conch of the ear (some being reinforced and some dampened) that they sound differently when heard, for example, at a point somewhat to the left and in front of the face and when heard at the left but toward the back of the head. Pure tones, being devoid of overtones, are not thus affected and therefore cannot be so distinguished.

In practical daily life we are able to estimate the distance of sounds as well as their direction. But this is a faculty which is very unreliable except where we are familiar with the sounds. It is easy enough to demonstrate that with the eyes closed a very faint sound near at hand is readily confused with a stronger sound further away. Gently sounding tuning forks afford the most convincing and ready proof of this fact, and everybody must at one

time or another have been deceived into thinking some faint sound, like the hissing of a steam radiator, was some distant object, in this case perhaps a locomotive blowing off steam.

Visual Space Perception.—In point of range and delicacy of spacial perception vision easily surpasses any of the other senses. Its range in distance is limited only by the clearness of the air and the curvature of the earth's surface. It detects direction instantly and accurately. It enables us to judge with great precision both the size and shape of objects. Thanks to the binocular nature of the sense organ we get a direct visual experience of solidity, for the right eye sees a part of a solid object, such as a pencil, hidden from the left eye, and *vice versa.* The stereoscope takes advantage of this fact and presents photographs which exaggerate this feeling of depth because they are taken from positions further to the right and left respectively, than those normally occupied by the eyes in looking at the object.

Although most of our judgments of visual distance are probably influenced by experiential factors involving touch and movement, the eye has its own mechanism for detecting distance changes, to-wit, alterations in the muscular sensations of convergence and accommodation, the former depending on the movements of the external muscles of the eye, the latter on the ciliary muscles controlling the lens. The size and distinctness of the retinal image also gives us a clue. The nearer the object the larger and more distinct the image. If we know the size of the object, we can estimate the distance; and conversely if we know the distance, we can estimate the size of the object. The accuracy of such estimates of course varies

with different conditions. Figure 46 illustrates the essential relations involved.

We also learn very readily to judge of distance relations by light and shade effects, as seen in the contours of a distant roof. Color aids us, too, and aërial perspective, but only when we have learned how to interpret what we see. Distant mountains, for example, tend to take on bluish and purplish hues.

Accurate and sensitive as vision is, it is nevertheless

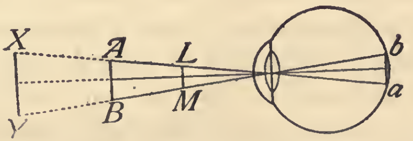


FIG. 46.—The retinal image *ab* of the object *AB* evidently is of the same size as the images of the object *XY* much farther distant and the object *LM* much nearer at hand. Unless our knowledge about the objects enabled us to make allowance for the different distances, we should be at a loss to know their relative size.

subject to certain striking illusions of which a few are shown in Figure 47, with no attempt to explain them.

Space Perception from Touch.—Touch has figured historically as the fundamental spacial sense, from which all the others are in a way derivatives. We have, at an earlier point, indicated the limits within which this statement is true. It is a fact that while under ordinary conditions vision is much more important to us as a space purveying sense, nevertheless in cases of doubt or hesitation we are wont to accept the verdict of touch as the final index of reality. In the spacial world of daily life, however, touch is simply one of a group of factors which

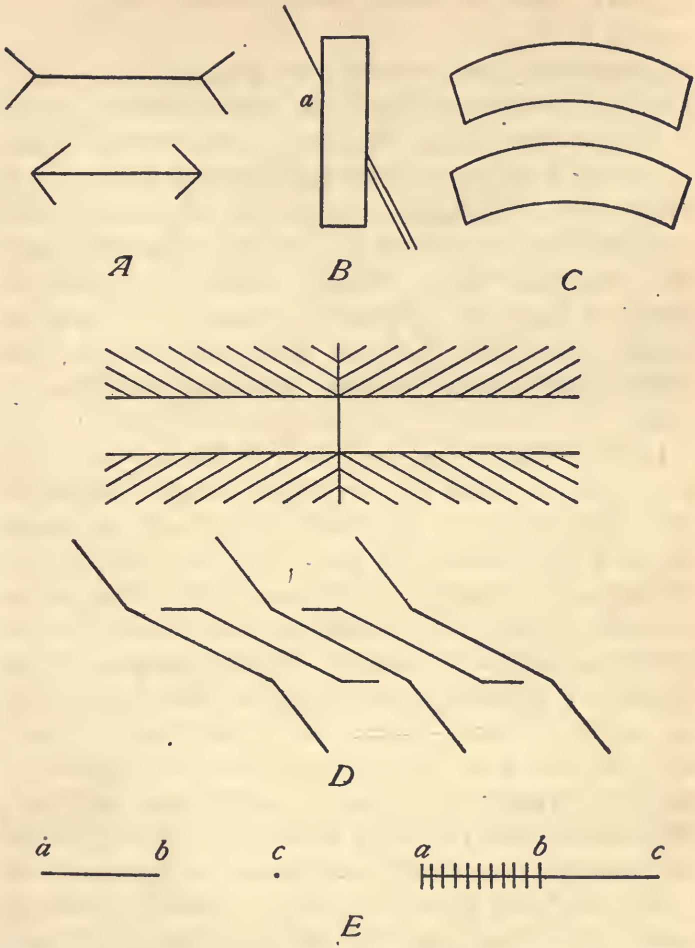


FIG. 47.—The horizontal lines in *A* are of equal length, although they do not so appear. In *B* the line which really continues *a* does not appear to do so. In *C* the lower figure appears clearly larger, although upper and lower are exactly equal in area. In *D* the parallel lines no longer appear parallel. In *E* the filled spaces, *ab*, appear longer than the equal unfilled spaces, *bc*.

coöperate with one another to give us our actual space world.

In the first instance, touch is the great medium through which we locate stimuli upon our bodily surfaces. It will be remembered that in our study of the nervous system we found it so arranged that the receptors from the skin surfaces are immediately connected in the central system with effectors leading out into muscles controlling these same cutaneous regions. This mechanism is obviously designed to enable the immediate movement of a stimulated region. Genetically there can be no doubt that the protective value of these localizing movements has been very great.

In the human being the power of localization on the skin varies enormously on the different body surfaces, as was suggested in the preceding chapter. On the finger tips and the palms of the hand, it is relatively delicate, on the back of the arms, on the back of the trunk, and on large parts of the legs the localization is crude and coarse. The truth of these statements can be promptly demonstrated by allowing another person, while one's eyes are closed, to touch lightly with a pen point the skin of the hand and the back of the forearm, and immediately thereafter trying with a similar point to touch one's own skin on the spots previously stimulated. The differences in the sensitiveness of the surfaces for localization will be immediately seen to be very great. Another interesting method of demonstrating the same kind of thing is to take a pair of dividers, separate the points by about an inch, touch the skin of the cheek with the two points just in front of the ear and then draw them lightly across the face, passing with one point just above and the other just

below the lips, and so across to the other ear. With the points a little closer together a similar experiment may be made by starting with the points on the tip of the inner side of the middle finger, thence passing up over the finger across the palm and up the wrist and forearm to the shoulder. In both experiments the points will be felt to be spreading and coming together again in the most amazing fashion. This is because the sensitivity of the regions explored is so very different, a fact explicable by the variations in the richness of the nerve supply in the areas traversed.

In addition to the power of localization, touch possesses also the capacity to report size and shape with reasonable accuracy. It arises from the only sense organ which is itself capable of conforming to a three-dimensioned object, e.g., when we grasp a golf ball in the hand, and it has been a favorite doctrine at one time and another that we are indebted to touch alone for all our original knowledge of the third dimension, or distance. However it may fare with this particular view, no one is disposed to question that touch, in connection with movement at least, does give us tri-dimensional experiences.

In speaking of touch in this way it is generally understood that temperature sensations are included. As a matter of fact, practically all touch experiences have some temperature elements attached to them, and in some cases this substantially affects our spacial judgments. For instance, an object which is distinctly hot or cold, if pressed upon the skin, is likely to be judged larger—and heavier—than the same object if thermally indifferent. A coin may serve to make such an experiment with. Of course it frequently happens that in passing from a

warmer to a colder temperature, as when one goes out of doors on a cold day, one encounters a considerable mass of temperature sensations without any accompanying touch experience. In these cases we get a general massive temperature impression, which has a certain vague spacial character, but unless it be combined with contact, we seldom think of it as possessing shape or definite size. Practically, therefore, we make little or no use of thermal sensations as sources of space experience save for purposes of very general orientation, as when we approach or move away from a source of heat. Cutaneous pain is even less significant as a factor in space perception.

Motor Sensations in Space Perception.—Although movement gives us through the sensations which it immediately evokes only vague, crude space perceptions, it is of the utmost importance in the exact use of practically all the other spacial senses. In the first place, it is to be remarked that kinaesthetic sensations are, as a matter of fact, all but invariably connected with other sensations, and particularly with the cutaneous group. If one moves the hand, thus occasioning sensations of movement from the muscles and joints, one simultaneously produces through changes in skin tension a group of touch impressions. If the eye be moved, there is again a group of vague, but real contact sensations, to say nothing of the retinal changes which also set up visual sensations. The anatomical conditions which bring about this conjoint excitation of kinaesthetic with other sense stimulations are no doubt responsible for the widely recognized fact that movement is largely employed as a measure of the other forms of spacial sensation.

In those types of experience in which we gain control

over the larger space relations it is fairly clear that movement sensations play some such part as that just intimated. For example, the child learns the real distance from side to side of a room only by creeping or walking. It is in terms of the effort required to pass from one point to another, that one learns to give some precise content to such a distance as the mile. In one sense the basis of all these spacial experiences is resident in the contact sensations coming from the soles of the feet, and in the visual sensations arising from the momentarily changing point of view. But the sensations which come from joint and muscle are quite as fundamental. These serve to punctuate, as it were, with each rhythmic movement of the limbs, the amount of the other sensory data, visual, tactual or what not, which is ultimately translated into terms of distance. Upon the product of these several factors is finally placed the conventional label in terms of feet or yards or miles.

It is interesting to remark in connection with this general commentary on the organization into a working system of our space perceptions from different senses, that there always remain outstanding certain unreconciled disparities. For example, the cavity in the tooth which feels so huge to the tongue is a poor thing when explored by the finger tip or examined by the eye. Many other similar instances could be mentioned. Doubtless they represent discrepancies in the reports of the several senses which have too little practical importance to occasion their reconciliation.

Organic Sensations and Space.—The organic sensations, other than those of the kinaesthetic group can, in the nature of the case, give us only space perceptions of our

own inner bodily conditions. For the most part the spacial impressions thus aroused, e.g., visceral sensations from the abdomen, are extremely vague in character. Certainly they play no important part in our general spacial orientation. The reflex functions of the semicircular canals while highly significant for the preservation of balance, and so for space adjustments, give us ordinarily little or no direct conscious report, so we need not consider them in this connection.

The Perception of Time.—We have seen that although taken literally every one of our senses may contribute to our appreciation of space relations, it is to a selected few, particularly vision, touch, and movement, that we are indebted for our more accurate estimates of distance, direction, shape, and size. In the same way all the senses may contribute to our appreciation of the passage of time. But it is especially to hearing and movement that we owe our more accurate estimates, at least for the briefer intervals for which we have something fairly to be called *direct perception*. The longer intervals of time are in general judged *indirectly* by means of symbols of one kind or another. Under civilized conditions of life, we are in constant contact with watches and clocks, and all of us who live in any measure a routine life are frequently reminded by the mere progress of our work of the amount of time which has elapsed. The bodily rhythms serve a similar purpose. Hunger, for example, does not allow us long to forget the accustomed periods for our meals. The changes of light and temperature which mark the sun's daily course give us other indications of time. For the longer periods, such as the week, the month, and the year, we rely upon various indirect measures, although the two

latter named intervals are marked more or less definitely, the one by the shifting phases of the moon, the other by the climatic changes incident to the rotating seasons.

Though in ordinary circumstances we have neither opportunity nor need for judging brief intervals directly, we find that when we set up experimental conditions we can judge most accurately, if we are permitted to use sensations of hearing and movement to measure off the time. Thus a series of rapidly succeeding sounds can be judged more accurately than a series of flashes of light. All such direct time judgments are periodic, that is to say, we break up a time interval into a series of 'moments.' These moments are not like the geometrical points, i.e., places without size. They are real durations, and may extend from a fraction of a second to several seconds in length. Whatever the actual length of such a moment, we treat it as a unit, and in comparing directly one time interval with another we judge whether or not one of these units is longer or shorter than another, or whether there are more or less of such units in a total interval.

Perception of Accent and Rhythm.—Our judgment of these immediately sensed time intervals is closely related to our perception of rhythm, in which evidently both duration and accent are involved. Here again hearing and movement are paramount, although there seems good reason to believe that vision, too, may contribute something. Our estimate of the duration of one interval in comparison with another is much affected by this fact of accent. An interval bounded by two loud sounds seems shorter to us than an equal interval bounded by weak sounds.

For certain of the arts, for example, music, poetry, and dancing, it would be quite impossible to over-estimate the

significance of rhythm. In a sense these arts are simply the soul of rhythm embodied in different kinds of sensory media. But so far as concerns the apprehension of time, it is fairly clear that while we are always more or less conscious of its passing, we tend to make the great mass of our judgments about it indirectly and by means of artificial indices. Only when we are overcome by the tediousness of a situation, do we tend to become vividly aware of the mere fact of time itself. Five minutes spent in interesting work passes literally before one knows it. The same interval spent in a dingy railway station, waiting for a train, takes on fairly portentous dimensions. One never knows just how serious a trial it is to be bored, until one encounters such an experience.

Conditions Affecting Apparent Length of Intervals.—Attention has often been drawn, and with good reason, to the change of attitude which we undergo as we grow older toward the commoner time intervals of daily life. In childhood the year appears an interminable prospect, spreading out in the dim distance ahead. The month affords in its turn a majestic outlook. Even the week is big with possibilities, and the day itself is not to be taken lightly, especially that part of it dedicated to the strenuosities of the schoolroom. In later life the perspective is wholly altered. Not only when we look backward, but even when we turn our gaze forward, the year becomes more and more a trifle, affording only grudging opportunity for the accomplishment of the absolutely essential thing. The shorter intervals tend to get wholly lost. To be sure, in some tedious lives, especially those which are lived under the shadow of ill-health, the month and the week may take on more impressive dimensions, but even so, as contrasted

with the conditions in childhood, all these intervals tend to shrink.

In general, this phenomenon seems to be due to the increasing domination of routine in our lives, and to the monopolizing of our attention in the mere execution of the daily obligations of life. In childhood the world is fresher, anticipation is more often whetted, the future is more uncertain, preoccupation is less intense and prolonged. All these factors make for a more vivid sense of the passing of time and tend to interrupt it more frequently in the mood of uncertain prospecting.

Another peculiarity of our estimates of time which deserves mention relates to our memory of the length of intervals, depending upon the manner in which they were passed. It is a common experience, for example, that despite the tedium of prolonged illness, we carry away in memory no vivid recollection, as a rule, to make such intervals seem long in retrospect. We well remember that we were bored to the verge of distraction, and that it often seemed as though the morrow would never come. But in retrospect it all shrinks completely out of resemblance to its original dreary length. On the other hand, intervals which pass like a flash when we are keenly interested and absorbingly preoccupied loom in memory as very long. This inversion of the memory estimate of a time interval as compared with our appreciation of it when in progress, obviously relates itself to the fact that in retrospect an interval is likely to seem long or short depending upon whether we can give it much or little content, can read back into it few or many events.

Peculiar Forms of Time Judgment.—A curious phenomenon which has often attracted attention consists in

the ability which some individuals possess to tell the time with quite extraordinary accuracy without appealing to watch or clock. The most skilful individuals can do this even when awakened out of sound sleep in the middle of the night. It is often combined with the ability to awaken from sleep automatically at any hour desired. We are at present rather in the dark as to the exact mechanism by which these results are achieved. Recent experiments indicate that a considerable group of factors may be involved, some of which are employed by one individual and some by another. If the subject be wakened in the night, his judgment of the hour may be based on the feelings of fatigue or freshness, or on the number of dreams since falling asleep, etc., etc. But for some gifted individuals the judgment is direct and immediate and not dependent on any such data. Reference is made to the matter simply because it serves to suggest in a somewhat impressive fashion the extent to which the organism is sensitive to temporal changes.

CHAPTER VIII

MEMORY

The analysis of the perception of time leads naturally to a consideration of those mental processes by means of which we are able to transcend time, to bring back into our minds events which are past, and to project ourselves in fancy into the future. We shall therefore turn to a discussion of memory and imagination, by means of which we achieve these two results; and first let us examine the main characteristics of memory.

At several previous points we have observed how past experience modifies present experience. Instincts reflect the successful struggles of thousands of former generations, and while it is not usual to think of them as involving memory in any usual sense, they may be regarded as disclosing a form of racial memory. Similarly we have already observed that in our perceptual processes we make constant use, however unconsciously, of past experience. But neither of these instances comprises the special kind of conscious memory which we mean to examine. This is best represented in acts such as those in which we recall our whereabouts a few hours ago, remember what we said and did, who was with us, etc. As James puts it: "Memory proper—*is the knowledge of an event or fact,* of which meantime we have not been thinking with the additional consciousness that *we have thought, or experienced it before.*" The term 'memory' is generally used more

loosely than this in common parlance and even in psychology. It covers the broad ability to retain and recall former experiences, without much regard to the important point emphasized in the last two clauses of James' definition.

So familiar are operations of this sort that we become quite insensitive to their altogether miraculous character. But a miracle it surely is that we should thus be able months and years after an event has passed to bring it once again into the focus of the mind's eye.

Retention and Recall.—It appears to the most superficial inspection that memory involves two distinguishable processes, *retention* and *recall.* After a thought has passed out of the mind, it may be absent for years and still at any time be within the range of recall. When it is actually recalled, it lives again, not precisely as it did at first, but nevertheless genuinely and in a way which may lead to practical consequences quite like those which flowed from it on its first appearance. If one asks where a thought is when one is not thinking about it, the question may strike the average individual as in the nature of a fatuous conundrum. In point of fact it is not only a perfectly fair question, but one whose answer carries with it highly significant consequences for one's general conception of the nature of the mind. To discuss the matter in detail is hardly practicable within the limitations set by the present book. Suffice it to say that in the judgment of the author the most convenient way of thinking about this phenomenon of retention is in physiological terms. Presumably, as we have previously seen, the brain tissues take up and preserve modifications impressed upon them by sensorial stimulations. When the stimulus is removed,

the modifications persist, some of them tenaciously and for long periods of time, others in a more fleeting and evanescent manner. When the process we have designated *recall* occurs, we assume that in some way or other these old nervous pathways through the brain are once more set in activity by impulses traveling over them and we become again conscious of the situation earlier experienced. We shall presently discuss certain features of memory training and point out some of the qualifications of a good memory. Obviously, retention and recall will play an important part in any such discussion. We turn first, however, to certain other facts about the memory process.

Forgetting as a Factor in Memory.—Contrary to the common impression, forgetting is really a very essential part of effective remembering, but one must choose with intelligence that which is to be discarded. Obviously, if our memories were freighted with the entire mass of trivial details of daily life we should be swamped. As a matter of fact, when we recall any ordinary episode, we get a highly schematic and abbreviated recollection in which as a rule only the more important aspects present themselves. All the rest has disappeared, and unless it be essential for the purposes in hand, it will not ordinarily be revived. The kind of forgetting which naturally attracts our attention is that which impedes or cripples our conduct, because we cannot at the appropriate moment recall just the required information. As compared, however, with the great body of the phenomena of forgetting, these cases are trifling in amount.

Many interesting studies have in recent years been made showing something of the manner in which forgetting proceeds, and here again ordinary impressions are apt to be

quite wrong. Figure 48 illustrates graphically the rate at which a process of forgetting goes forward. If one memorizes a list of numbers so that they can just be successfully repeated, the process of forgetting proceeds most rapidly in the first few hours after the act of learning. Then, as the curve shows, the process tends to slow up until finally a point is reached, after which it becomes practically impossible to measure the further loss. Most people sup-

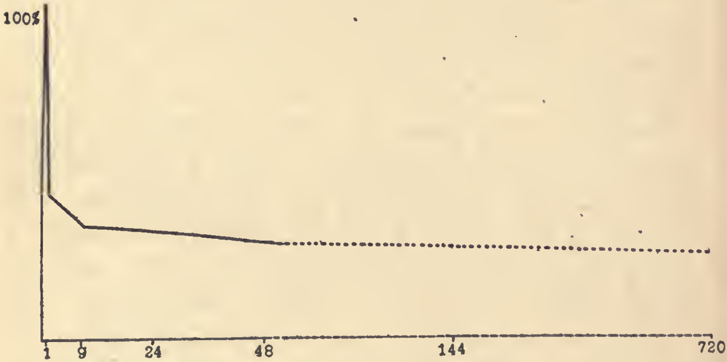


FIG. 48.—Curve of forgetting based on Ebbinhaus' study of memory for nonsense syllables memorized to the point where they could be correctly repeated once. The vertical line represents the percentage of the material recalled after lapse of increasing intervals of time indicated on the horizontal line, to wit, 1, 9, 24, 48, 144, 720 hours respectively. The curve for material conveying meaning and not learned verbatim would be quite different. Under such conditions association of various kinds enters to modify the permanency of the memory far more than in the case of nonsense material, although even there it can be shown to exercise some effect in increasing the duration of retention. (Modified from Pillsbury.)

pose that there is very little forgetting immediately after the completion of such a learning process, but a little experimentation will disabuse the mind of this conviction.

Distribution of Effort in Memorizing.—Clearly this

fact has important implications for students who are attempting to master new subjects that call for verbatim memorizing. There is a considerable amount of supplementary experimentation dealing with other aspects of this same matter, tending to show that the *distribution* of one's effort is a matter of prime consequence, not only in the economizing of time and energy, but also in the securing of permanent results. These experiments relate not only to the mastery of intellectual materials, such as would be represented in ordinary college studies, but also to the acquirement of acts of skill, involving muscular dexterities of various kinds. Experiments have thus been made dealing with the acquirement of a language, as an illustration of an ordinary intellectual task. Others have dealt with the attainment of skill in the throwing of balls, in the shooting of arrows, in the mastery of the typewriter, and so on. Although the precise time relations naturally vary with the special task, all the experiments tell the same general story in making clear that there is a very wide choice among the various methods of distributing one's attempts to learn.

All students are familiar with the process of cramming, by means of which even the most neglectful are sometimes able successfully to survive the rigors of an examination. There can be no doubt that for practically all persons, and for some favored souls in high degree, it is possible, by the devotion of a closely sustained effort of memory covering many hours just preceding an examination (if it be of the type chiefly testing accuracy of recall), to carry a sufficient body of facts in mind to come through the ordeal with some vestige of credit. Meantime, for the great majority of persons there is equally no question that

matter memorized under these conditions is lost almost as rapidly as it is gained. Exceptions must be made for the occasional individual who can under these conditions not only learn rapidly, but retain the facts acquired with moderate tenacity. Indeed, it may be mentioned at this point that people may be divided into four fairly distinct memory groups: (1) those who learn slowly and retain well—a not uncommon and on the whole a generally effective type; (2) those who learn slowly and forget quickly (except in pathological cases not a very frequent type); (3) those who learn quickly and forget quickly, an extremely common American type; and (4) those who learn quickly and retain well, a rare but *bona fide* and eminently fortunate type.

While it is impracticable at the present time to lay down any hard and fast rules, valid for all kinds of work, it is quite possible to indicate the general principles which should be observed to secure effective memorizing. Obviously, if the process of forgetting goes on most rapidly soon after the completion of an effort at learning, it will be well to repeat the process before the forgetting has proceeded so far as to require a disproportionate repetition of the original labor. On the other hand, a too long continued *effort* will not only defeat itself because of fatigue, but also because (if we may judge the import of a considerable group of recognized facts) a certain amount of time is required for the modifications impressed upon the nervous system to sink in and set. If the attempts at learning be so distributed as to coincide closely with these beneficial periods of 'setting' in the nerves, we shall presumably get the best results in terms of economy of total time and energy expended. In the preparation of ordinary

academic work, these considerations would lead one, in contrast to the cramming method, to distribute one's study over a relatively long period of weeks or months, with frequent repetition of the material one is attempting to master.

The problem confronting the ordinary college student relates to the arrangement of daily work rather than to the organization of the tasks covering a series of days. In this case exactly the same doctrine holds true, but the foregoing illustrations may perhaps seem to be less immediately relevant. The average student hardly gets over the daily assignments once, leave alone any question of repeating the exercise, so that to urge a distribution of effort on the ground that a repetition at interrupted intervals is advantageous seems somewhat beside the mark. It is certainly true that if the student cannot so arrange his work as to cover it more than once, the principles under consideration cannot be made to apply to him very obviously. But in practically all cases an industrious student can go over his assignment twice, the second time by way of review, and in this case he will find the permanency of his retention decidedly enhanced by making such a repetition or review at a time separated by a few hours perhaps from his first encounter. Needless to say, the peculiarities of different forms of subject matter play a real part in such a situation. Languages, mathematics, and history are likely each to present certain idiosyncrasies not common to the others. Certainly a little conscious experimentation on this matter will be found of unequivocal benefit by any serious student.

Many students, and among them generally the most conscientious, are apt to suppose themselves peculiarly vir-

tuous if they devote themselves for as many hours of consecutive work as they find necessary to cover a particular assignment. As a matter of fact, this often results in a grotesque waste of time because the student's mind becomes dull and tired and fails to work at anything like its normal level. It would be much more sensible to interrupt the work at that point where *genuine* fatigue sets in, to turn to some other subject, or better yet, to get the air and some moderate form of recreation, with a return to the mental labor itself at a later period in the day. The moral virtue which is no doubt inherent in the course described is unfortunately largely negatived by the psychological viciousness of the process. Our schools and colleges are as yet very largely oblivious to the increased efficiency possible in the work of students by an intelligent organization of their periods of work. Nor is it simply a matter of efficiency; it is also a matter which involves fundamentally the joy and satisfaction of a proper use of one's mind.

Typical Defects of Memory.—Fallacious memory, as it occurs in normal individuals, usually takes one of three forms: (1) facts may be recalled in an order different from that in which they originally occurred, (2) certain facts may be forgotten altogether, or (3) facts which never occurred will be inserted in the memory of those which actually did happen. These errors of memory may all be easily verified by attempting to memorize lists of eight or ten digits. In recall some of the digits will occur in changed order, some will be omitted altogether, and others will drop out and substitutes present themselves quite without the knowledge of the experimenter.

Certain diseases of memory give us an interesting insight into the principles of its organization. In the disease

known as dementia, there is practically a complete loss of memory. The same thing is met with in the case of shock as the result of an accident, like a railway collision. Even severe emotional shock, caused for example by the unexpected receipt of bad news, may produce this result. Aged people come in time to suffer from much the same complete destruction of memory.

Partial destruction of memory may be illustrated by cases which affect either (1) a special segment of time, or (2) some special group of subjects, or (3) the imagery connected with a particular sense. After an accident, persons are often unable to recall anything which occurred for several hours preceding the event and for appreciable intervals of time thereafter. In this case the loss affects information of every kind covered by the period of time involved. Quite different from this is the loss of memory for music, or for a foreign language. Here there is no question of a special interval of time; the defect relates entirely to an interconnected subject matter. Again, there may be a more or less complete loss of visual images, so that one cannot recall the appearance of objects. These facts suggest the various kinds of bonds which hold memories together.

The disintegration of memory in old age already mentioned is a familiar phenomenon closely related to the facts just described. One of the first groups of memories to disappear is that of proper names. Odd as it may appear, abstract ideas seem to be more tenaciously retained than those of a more concrete character. In any event, this is true of the words which we use to designate such ideas. Nouns tend to disappear in advance of adjectives and verbs. This may mean that we use the latter oftener and

in more varied connections, so that we have a larger reservoir of experiences upon which to draw. Perhaps it means that we can conveniently use other kinds of memory material for the objects designated by nouns, and that in consequence our verbal memory for them is not so well drilled. Thus we can recall the appearance of a table by means of a visual image. Whatever the explanation, the facts are as we have stated. Elderly people are also often forgetful of very recent events, while recalling with great vividness the experiences of childhood. This fact is no doubt due to the loss of plasticity in the brain for new impressions.

The Conditions of a Good Memory.—"A good memory . . . would seem to depend upon (1) ease and rapidity of acquirement, (2) permanency of retention, and (3) the ability to recall information promptly and accurately when wanted. These results clearly involve (a) the original act of impression, (b) the process of retention, and (c) the act of recollection. The original impression and the act of recollection are under our immediate control. The process of retention, once a stimulation is given, depends upon the brain tissues, whose condition we can improve only indirectly by giving ourselves healthful habits and hygienic surroundings."

So far as concerns the original act of impression, it is in the highest degree essential, if memory is to be accurate and tenacious, that there shall be the greatest possible concentration of attention. There can be no reasonable question that the variations in the efficiency of the memories of different individuals are largely occasioned by their different powers or habits of concentrated attending. We give concentrated attention *naturally* to things which interest

us and to things which are emotionally exciting. We have also to some degree the power through sheer effort of will and resolution to focalize our attention for a time even upon subjects which are *per se* neither interesting nor exciting. The attention given to a considerable part of the ordinary student's work is likely to have in it something of this more or less heroic mastery of one's mind, but it is obviously vastly easier to attend where our interest is sincerely enlisted, and it is for this reason that not a little of modern pedagogical theory has insisted that education be so organized as to appeal at each stage to the natural interests of the average boy and girl.

The original impression can sometimes be augmented by appealing to more than one sense avenue, as when, for example, a word is spelled out loud and also written. The Chinese secure a form of intensified attention by reading their lessons aloud. Impressions can obviously be made much deeper by repetition, and for materials which must be mastered *verbatim* continued repetition will practically always bring success, however tedious the process.

Much more important in retaining an impression is the association of one fact with other logically related facts. A date in history which is in this way knit up with a great group of antecedent circumstances and a similar set of subsequent events, becomes part of an organized system of ideas and is not likely to be lost, unless the entire group to which it belongs disappears.

On the negative side, anything which serves to minimize distraction will be helpful. Freedom from disturbing noises, from draughts, from uncomfortable chairs, from unduly interesting scenes, is of signal importance.

It is of course evident that while the points touched upon

in the last few paragraphs all relate to the matter of securing desirable original impressions, the practical consequences for the memory process are to be found at the moment of recall. In this connection it will be remembered that, earlier in the chapter, in discussing the process of learning and the connected process of forgetting, the significance for retention of *recency* of stimulation was pointed out.

No single procedure which can be readily commanded is likely to be more serviceable in securing tenacious impressions than the immediate *practical application* of any item of information which has been memorized. Obviously the special kind of application will depend upon the character of the information. It may be something relating to the use of tools, in which case it should be embodied in the actual manipulation of the tools. It may have to do with geometry. If so, it should be put into immediate demonstration with models or drawings. If of a more abstract character, it may at least be discussed or embodied in some written form. It is of much less consequence what special use is made of it, although this is important, than that it get *prompt application* somewhere. The conception which was introduced in the opening chapters of the book would lead us to expect exactly such a result as this, because we saw that all our mental processes take their rise out of conditions of motor control, and it is therefore natural to expect that the best results will be obtained wherever we realize the translation of sensory and ideational processes into effective motor activities.

Transfer of Training.—An interesting question is suggested at this point. Does training the memory in one subject improve the memory process for all subjects? Until a

few years ago almost everyone would have answered this question with a vigorous affirmative. Some of the first experiments, however, initiated to investigate the facts led to an equally positive denial. More careful and exhaustive experiments seem to show that the general value of memory training secured in any special field, e.g., language study, is greatest for closely similar subject matter, that it diminishes rapidly for subject matter more and more remote in character, but that some effect is traceable in practically any other task undertaken. The same thing holds for other kinds of training, e.g., muscular skill, where one sometimes encounters *negative* transfer. A man who has learned to speak one foreign language may even find it more difficult to learn a second of very different structure, than he would have, had he not learned the first. In general, however, any systematic, controlled discipline of attention seems likely to leave behind some positive benefit for other forms of intellectual work, and memory is no exception to the general principle.

Improvement of Retention and Recall.—It has already been pointed out that retention is primarily a matter of the brain and nervous system, over which we have only such indirect control as is represented by our ability in a measure to gain and maintain conditions of health. What has been said about securing effective original impressions comprises most of what is to be said about recall itself. To be most effective, it usually requires conditions of high concentration of attention.[1] If baffled at any point, it must

[1] A curious exception to the general rule is found in the not uncommon experience of trying to recall a forgotten name. The more one tries, the less one succeeds. If the mind be directed to some other matter, the name often comes back without more ado. These cases are probably due to temporary blockage in the synaptic con-

show itself flexible and alert to utilize every trail of suggestion, to neglect quickly those which are unfruitful, and to follow relentlessly those which promise success. If we have built up our material on well organized lines, we shall find our memories commonly serving us well; but a memory which has never been subjected to persistent discipline is always likely to prove treacherous, both in failing to supply that which is needed and in often presenting wholly fictitious material as fact.

In this general connection it may be remarked that hypnosis gives us evidence that normal recall has access to very much less memory material than is actually preserved in the brain. In hypnotic sleep it is found possible to tap reservoirs of memory which are ordinarily closely sealed. A rough analogy to this situation is perhaps afforded by the supernormal muscular power evinced in mania and some other forms of nervous disease, when the nervous and muscular systems are often forced to a far more violent discharge of energy than usual.

Mnemonic Systems.—Certain readers will have seen advertisements of systems of memory training, and will wish to know something of their value. It is impossible to enter fully upon the matter here. Suffice it to say that in addition to such considerations as have been already rehearsed, the most successful systems exploit the creation of great varieties of arbitrary association, by means of which one may pass from one fact to another. A list of forty or fifty words may thus be memorized on a single reading by virtue of arranging them so as to exploit such associa-

nections in the brain, of the character, perhaps, of passing fatigue. Effort of attention only aggravates the inhibitions, which generally pass away of themselves after a time.

tions. Four or five words will serve to illustrate the point. House—chimney—smoke—tobacco—cigar—Cuba—Spain—King. Other systems begin by obliging the user to memorize a very elaborate framework, which then serves as the rack upon which by means of these arbitrary associations are hung all specific facts to be remembered.[1]

It may be said in general of systems of this kind that for some very limited purposes they may be of real value, but as bases for any thorough development of memory they are distinctly less useful than the methods we have described, assuming an equal investment of time and energy in the process of training.

[1] "Suppose one has occasion to remember a great many unrelated numbers, like the street addresses of a large group of people. One may greatly facilitate such a feat by first memorising a "form," in which each digit is connected with a consonant, e.g., the 1 with t, 2 with l, 3 with d, etc. The next step is to make a word easily suggested by the person whose number is to be remembered, in which these letters shall occur in proper order. For example, Mr. Smith's number is 122, Mr. Smith is tall. The word tall in the number form means 122, for the vowels are neglected."

CHAPTER IX

IMAGINATION

At the outset of the previous chapter, we commented upon man's remarkable capacity to look either forward or backward far beyond the limits of the present moment of time. We then described certain important general aspects of memory. Now we must turn to a discussion of a more intimate kind regarding the psychological material employed in the memory process. This undertaking will be found to lead naturally to a study of imagination, the mental device by which we anticipate the future.

Imagery the Medium of Recall.—We have seen that we possess an organic form of memory which preserves for us as reflex and instinctive acts, certain useful adjustments which our ancestors acquired at some time in the remote past. Much of this type of memory has relatively little of the psychological now in it. Conscious memory is very largely made up of imagery, that is to say, of the reinstatement of sensory experience in ideational form. Looking at a book lying on the table, and then closing the eyes and attempting to see it mentally as it was a moment before, most people succeed with reasonable promptness in producing a mental visual picture of the book, which for many of them possesses considerable fidelity of detail, both as regards color and form, and which for others, although vaguer and less distinct than the original, is still unequivocally visual in character. Interesting experiments have

shown that some persons are able to project these visual images out into space and hold them before the attention fixedly enough to permit comparing them with actually present physical objects. The reader may readily convince himself by trial whether or not he can achieve this projection, and if so, in what manner the images thus projected differ from the objects actually seen.

Similarly, if a melody be played upon the piano, many individuals are able immediately thereafter to 'hear the tune running through the head.' The tonal quality of this secondary mental experience is for many persons perfectly unmistakable, and it involves what psychologists know as auditory imagery. It is quite likely to be combined with more or less definite throat and lip movements, such as would be used in singing or whistling. Practically every sensation may in this way be repeated in the form of imagery, although there is very great variety among individuals as regards their ability to command one or another form. Certain persons have a marked preference for one or two varieties of images, and may be quite lacking in some or all of the others. Generally speaking, vision, hearing, and the kinaesthetic senses [1] are most richly represented.

The cutaneous group, together with certain organic sensations, probably comes next, with smell and taste competing for last place.

In all cases of detailed revival of past experience in memory, we make use of one or another variety of these

[1] Some psychologists doubt whether kinaesthetic images are ever experienced, because they believe that every attempt to secure them results in the contraction, slight though it may be, of the corresponding muscles, thus arousing kinaesthetic *sensation*.

images as the means by which we reinstate mentally the particular event or fact to be recalled. This does not mean, however, that we necessarily recall events by images corresponding in sense quality to the nature of the original sensory experience, although this is often the case. For example, the memory of a street scene may come back in the form of visual images, but this is not inevitable and for persons who have but little control over visual images, some other type of imaginal material may be employed. Probably the commonest substitute imagery is linguistic; that is to say, one may bring back in the form of words, facts and events which may originally have been visually experienced. In this case the words are apt to be embodied in auditory imagery, or in the form of motor images of the movements of the throat, tongue, and lips in speaking. The two are with most persons regularly conjoined. This conjunction is a natural expression of the law of habit, inasmuch as when we speak, we necessarily hear our own voices and so set up an intimate association between the motor and the auditory linguistic elements. Somctimes the recall occurs in the form of nascent spoken words. We 'talk to ourselves' as the method of revival. Again, the memory may consist almost wholly in assuming the motor attitudes of the remembered experience. When we come to discuss reasoning processes, we shall have occasion to describe in greater detail some of these substitute devices by which we use one kind of mental material to represent another. It should also be added that some psychologists believe that they recall events by 'pure thoughts' having no imagery and no sensory or motor elements about them. The present writer thinks the evidence for these imageless memories unconvincing, especially where any attempt is made to recall

precise details. It must not be forgotten, however, that our practical use of imagery for any purpose whatever involves our apprehension of its *meaning,* and it is generally the meaning and not the particular sensuous form of the imagery which is significant and important.

Relation of Imagery to Anticipation and Imagination in General.—All that has been said about the use of imagery for the purposes of recall is equally true of the use which we make of it for purposes of anticipation. When we look forward in making a plan, we employ for the purpose mental imagery of one kind or another. Many people —and the reader can readily assure himself as to whether this be true in his own experience—in formulating an itinerary for a journey, find themselves drawing upon their visual imagery, by means of which they portray to themselves the scenes which they expect to behold and the several stages of their progress. Again, it is a familiar form of mental organization which, if confronted with the necessity of deciding between conflicting lines of conduct, has recourse to a sort of mental debate in which auditory and motor language imagery is drawn upon and first one side and then the other is defended. This often goes so far that it ceases to be purely imaginal and becomes a suppressed but actual enunciation.

Perhaps the most unequivocal instance of imagery with which the ordinary individual comes in contact is found in the dream. In waking life many persons find it difficult to be sure whether they have any images at all. But in the dream everybody acknowledges the presence of imagery and most persons can readily describe it. In the more exciting dreams the vividness of the experience seems frequently to exceed that of ordinary waking perceptions.

We suggest, therefore, that any reader who finds it difficult quickly to identify his images, turn to his recollection of dreams.

The term *imagination* is apt, like the connected terms fancy and fantasy, to suggest to many persons wholly unreal forms of experience. Of course, there is a sense in which this implication of the term is justified, as when we speak of imaginary ailments, or of castles in Spain. But this is a very small part of the psychological story. Imagination, which is simply a general term to cover our use of imagery, is obviously one of the basic realities of our mental life. The chief means by which we remember the past and anticipate the future could be nothing else. The fact that we also use it occasionally to conjure up fiction in no way lessens its essential importance.

Ideas and Images.—Before going on to some of the details regarding our methods of using imagery, it will be well to dwell for a moment upon the term *idea* and its connection with the term *image*.

One of the difficulties which the beginning student of psychology encounters arises from the fact that in common language we speak of recalling *ideas*, or of having ideas about the future, while we say nothing at all about images. Nevertheless the psychological usage is entirely justifiable, and a brief explanation will make the matter clear.

When we speak of understanding the ideas in a book which we are reading, or in an address to which we are listening, we imply that we apprehend the *meaning* of that which is written or spoken. Similarly, when we have been thinking about a subject, we often describe the situation by saying that 'certain ideas have been running in our

minds.' In neither of these cases do we have any occasion to remark, and much less to emphasize, the special imagery with which our minds have been filled in the process of following or developing the particular meaning involved. But upon a closer scrutiny of the actual situation, we shall find that to a greater or less degree we have been making constant use of one or another form of imagery, often with an appreciable admixture of sensations arising from our motor attitudes, which may be used as carriers of our meaning—e.g., the attitude of expectancy when thinking about an approaching event. Image and idea somewhat like sensation and perception, are, therefore, not two different mental states, but one and the same, described now from the point of view of particular sensory texture and now from that of organization and meaning. If we wish to emphasize the fact of sensuous composition, whether auditory, visual, or whatever, we use the term image; if the *meaning* of the imagery is the important matter and the special sensory texture is unimportant, we may use the term idea. For ordinary purposes, the latter is nearly always the significant matter, and consequently we tend to overlook its actual basis in sense perception or in imagery. But when we take the psychological point of view, it becomes quite essential to note and describe the special form in which the idea or meaning is embodied. With this in mind, we may always understand that when we speak of ideas we are referring to the meaning of images or perceptions, but that in the particular immediate context the imagery is unimportant.

A very common and fundamental distinction, which is sometimes thought of as substantially equivalent to the distinction between memory itself and imagination, is that

between the productive and the reproductive forms of imagination.[1]

Reproductive Imagination.—In so far as an image substantially copies previous sensation or some other antecedent image, it would be designated as reproductive. The usual notion of memory involves some such direct and unmodified recurrence of an original experience. As a matter of fact, probably no image is ever in any absolutely literal sense a mere copy of a previous experience. Differences of detail, to mention only a single point, are almost invariably present. Nevertheless, were we to compare the sum total of our images with our past experience, we should find many so closely resembling the sensory originals from which they spring, that we should naturally regard them as copies. On the other hand, many images are clearly combinations of two or more originals, while in the case of still others we find it practically impossible to trace their sources.

All verbatim memory clearly involves reproductive imagery, but as has been intimated earlier in the chapter, we may use vicarious memory materials which would not in any usual sense be called reproductive. It is thus quite possible to recall an event, such as an automobile trip, largely through the medium of auditory-motor word imagery, despite the fact that the most impressive events which now come back into the mind were themselves of visual character. Imagery used in this way evidently cannot be said in any proper sense to copy the original experience as visual imagery perhaps might do. It is rather symbolic in character, it represents, or stands for, an experience which in its sensory texture was quite different

[1] See James' definition of memory on page 137.

from the imagery employed in its recall. Words, through whatever imaginal channel recalled, are, in the nature of the case, almost invariably symbolic so far as concerns the objects, acts, or events to which they refer. Thus the word 'dog,' whether it be seen or heard or spoken, whether it come into the mind as a sensorial or an imaginal process, bears no more resemblance to the actual animal so named, than it does to any other object whatsoever. It is a mere symbol and the French word, chien, or the German word, Hund, will serve the purpose quite as well, although neither bears the remotest resemblance to the English word.

Productive Imagination.—Productive imagination is obviously the form which we employ for anticipating the future and for freeing ourselves from a merely slavish adherence to past experience. It goes without saying that great scientific inventions, like great works of art, rest upon the powers of constructive imagination. The actual imagery employed may be of any kind whatever, although certain forms are obviously more significant than others for particular arts, e.g., visual images for painting and sculpture, auditory and motor for music. What is not so clear, but nevertheless equally true, is that all constructive thinking, from the most practical to the most theoretical, involves the utilization of productive imagination. This matter will be touched upon in a later chapter. The only qualification which needs to be imposed at this point relates to the generally accepted fact that practical results of crucial consequence occasionally arise as the outcome of brain processes in the cerebrum which are not necessarily represented in the field of conscious imagination at all. The results, but not the process by which they are brought about, appear in the mental field. The sudden flashes of

insight, the solution of problems temporarily given up and forgotten, are illustrations of the sort of thing referred to.

It remains to examine some of the principles determining the sequence of the successive links in a chain of thoughts or images. This is a problem which has interested every generation of psychologists, from Aristotle down to the present time.

The Association of Ideas.—That ideas which have for any reason been connected with one another in the past tend to hang together, so that if one presents itself to the mind the others tend to come with it, has attracted again and again the attention of even superficial observers. In like fashion the tendencies of ideas to suggest others which resemble them has repeatedly been noticed. Psychologists have tried on the one hand to analyze and describe all the actual principles which thus unite ideas, and on the other to ascertain if possible the causes bringing these results to pass. We shall comment briefly on both aspects of the situation.

The dominant tendency today is to seek for an interpretation of association in terms of the activity of the brain and nervous system. We have already commented upon the view that *retention* is primarily a physiological function, a property of the nervous system. As nervous excitement is generated in the sense organ by a stimulus of one or another kind, it is passed forward through the central nervous system until finally it makes its appearance in the field of muscular movement. The precise pathway traversed by such a nervous impulse will of course depend upon the permeability of the chains of neurones, especially at the synaptic junctions where one neurone comes in contact with another. Thus a stimulus upon the skin of the

hand may be immediately converted in the spinal cord into a reflex impulse moving the hand; or the impulse may be transmitted up into the cerebral cortex, thence to reappear in a movement of the entire body. Which of these consequences follows will depend upon the resistance at the synapses, and this resistance, other things equal, will be low if the pathway has been frequently *used before*. In other words, previously established habits will be influential in determining what shall occur.

Presumably the same principles which determine the course of a sensory impulse through the nervous centers to a muscle, control the action of the cerebral cortex when thinking of any kind is in progress. It is quite certain that the nervous currents will tend to flow in the direction where the synaptic resistance is lowest. Clearly a considerable number of factors may enter in to determine these resistances. For instance, if an extensive system of neurones is already in an excited condition, the resistance in such a system is likely to be lower than in an inactive system. Again, there is good reason to believe that a chain of neurones which has been *recently* excited presents a condition of lowered resistance relatively to other chains which have been more remotely stimulated. Again, the evidence is entirely conclusive that such a chain, if repeatedly excited, tends to take on an almost reflex character. All these considerations and some others can be translated into psychological terms of imagery and ideas, and this we may at once proceed to do. Let it not be forgotten, however, that these principles were first worked out by a study of the strictly mental processes. More recently a certain amount of direct neurological evidence has been gathered, and present day tendencies, as stated above, favor a rec-

ognition of the neural principles as basic for an understanding of the temporal order taken by thoughts.

Association and the Law of Habit.—All the principles of association may be considered as in one way or another expressions of the general law of habit. *Frequency* of connection is the most obvious instance of the principle. Ideas which have been frequently united tend to recall one another at the expense of less frequently connected thoughts. The date 1492 is in this way associated with Columbus. *Intensity* in an experience may serve to bind permanently together psychological elements that otherwise would never suggest one another. The thoughts of the several moments of a very terrifying experience, e.g., escape from a sinking ship, may thus become permanently fused. Again, the *recency* of a conjunction may bring it about that the train of ideas reflects this connection, rather than others which have been more frequent, and even some which may have been more intense.

Evidently these three factors, if they were the only influences at work, might make it substantially impossible to predict in a given case what associations should actually dominate, because it might well occur that a particular idea *a* should have been frequently connected with *b*, recently connected with *c*, and at some remote time vividly connected with *d*. Synaptic conditions would therefore permit that the idea *a* should lead to *b*, *c*, or *d*. Which one actually succeeds *a* will depend upon the momentary condition of the brain, which we have no means of determining. Meantime, it is clear enough that the sequence of ideas is determined by perfectly definite causes, even if we are not in a position to state in a given case just what they are.

Undoubtedly among the most important determining

factors are our interests, temporary or permanent, and our emotional mood. If our minds are preoccupied with some exciting or entertaining train of thought, it is practically impossible for ideas connected with wholly different topics to arise. Similarly if we are in the clutch of any strong emotion, only such ideas as are relevant to its course can get a hearing, or indeed, can reach the field of consciousness at all. On the side of the brain the presence of an emotion or of an active interest involves the activity of considerable groups of neurones belonging to connected systems.

No account of association would be correct which implied that the succession of ideas one upon another could be explained in terms of single ideas. For example, the fact that idea *b* follows idea *a* is probably never completely to be accounted for by the presence of *a* alone. Certainly in all ordinary instances the appearance of *b* is due to the entire context amid which *a* appears. Thus the idea wood brings up an entirely different group of associates when it occurs in connection with the search for fuel and in connection with an examination of furniture. The memory of words affords innumerable instances of the same kind of thing.

The Association of Similars.—Few forms of association have attracted more attention, and perhaps none is more significant for human thought processes, than that of *resemblance*, or *similarity*. The older writers on psychology used to group the various forms of association under the headings contiguity in space and time, similarity, contrast, cause, and effect. The reader will readily recognize that we have already in substance dealt with the case of contiguity and to some extent with that of cause and effect.

In our original comments upon association were cited instances in which ideas which had previously occurred together, or in immediate succession, tended to recall one another. Associations involving contrast, e.g., black-white, large-small, etc., are closely related to the cases of contiguity and we shall not pause to discuss them, but a few further words must be devoted to associations involving similarity.

It is in this type of associative sequence that we seem to break most completely with past experience and seem to achieve freshness and originality in the order of our thought. It has often been said, and probably with much truth, that it is our wide and subtle use of this kind of associative nexus which marks us off most unequivocally from the animals. Ideas which are similar may recall one another, even though they have never before been in any way immediately conjoined in a thought process. The resuscitation of ideas which have been contiguous in previous experience affords an obvious illustration of the operation of the law of habit, but the association of similars seems at first sight to violate this principle absolutely. An instance or two of the type of thing involved may profitably be cited.

When we are walking on the street, we may pass a person whom we know to be a stranger, but whose face we at once feel resembles that of an acquaintance. Sometimes we are able to recall and identify the suggested individual, but in other instances we may be quite at a loss thus to place the resemblance. In such circumstances the order of events is as follows: (1) perception of stranger, (2) feeling of familiarity or resemblance, (3) thought of the suggested person. The third step is, as we have just remarked, some-

times wanting. Just the same sort of sequence of events may occur when an idea or an image, rather than a perceived object, initiates the train of associations. Another type of case is represented by having one idea succeed another in the mind, whereupon we then notice a similarity between them. For example, while looking at a painting, the memory of another suddenly comes into the mind, and at once we remark their similarity to one another. In this case the appreciation of similarity occurs *after* the completion of the association, instead of as a preliminary step in the process.

The neural explanation which is now generally accepted for associations of the similarity type involves the supposition that thoughts which resemble one another involve brain processes which at some point have *identical* elements. This means that if two individuals really resemble one another we shall, in perceiving them, employ to some extent identical nervous pathways. Consequently, when the idea of one of them is again experienced, the brain processes involved will be in part the same as those brought into action when the thought of the second comes into the mind. There will thus be the possibility, from the neural point of view, that one of these brain systems may, when active, suddenly stir up the other. Strictly speaking, such a process seems to involve a departure from the usual habitual type of nervous activity, but it clearly frees us from the necessity of admitting that the succession of thoughts is frequently, if indeed, ever, altogether and completely novel. Some connection in previous experience is on this theory always to be discerned in associations of ideas.

All the great minds, especially those of the scientific and

artistic kind, are apparently marked by a very high development of the capacity of association of similars. This is particularly true of poets, the witchery of whose verse is often in large measure due to the subtle delicacy of metaphors resting upon the use of resemblance, in forms wholly foreign to the prosaic mind.

> "yet his eyelids
> Widened a little, as when Zephyr bids
> A little breeze to creep between the fans
> Of careless butterflies:"

Certain it is that the great constructive achievements of science and philosophy make the most drastic demands upon the mind for a large use of this type of association. It is also not without interest that a certain variety of association of similars characterizes the thinking of little children and persons with disordered minds. In these latter cases the associations are devoid of fundamental significance, and in consequence lead to little or no practical result. Wit and humor depend largely on similarity associations, with the pun as perhaps the lowest form. In other words, the great accomplishments of human intelligence require not simply the use of similarity, but a nice sense for the distinction between those forms of it which are really pregnant and those which are futile.

The Training of Imagery.—Attention has been called at an earlier point in the chapter to the fact that individuals vary as regards their control over different kinds of imagery and as regards their native preferences in the use of one kind or another in their thinking. It will be recognized that within limits there may well be considerable advantage in the ability to use special kinds of

imagery in the solution of particular sorts of problems. The question naturally arises, therefore, whether one can train imagery, and if so, how to go about it.

The best experimental evidence seems to show that a very considerable development of specific imagery may be achieved by the voluntary attempt to make use of it, provided there be a reasonable body of it available to start with. One can thus by very little effort develop visual imagery by compelling one's self, for example, to solve simple geometrical problems by means of such images. Nobody has as yet hit upon any reliable method for eliciting imagery which is at the outset substantially lacking. Owing to our ability to substitute one form for another, it is found very difficult to create conditions which in any complete way compel us to use a particular type.

It is not without interest in connection with this general question of training imagery to note that the forms of imagery which are preferred do not necessarily correspond to the sensory processes which are preferred. One may, for example, learn most easily by the ear, and still make little use of auditory imagery; or one may learn most readily through the eye and yet rely but little upon visual imagery for recall.

After all, the great point is that whatever forms of imagery one employs, they shall be flexible and reliable. Practice is the only road which one can travel to secure these ends.

In concluding this chapter two curious groups of phenomena relating to imagery may be mentioned. The first known as synaesthesia might just as properly have been mentioned in connection with perception.

Synaesthesias.—When the ordinary person hears words

spoken, or hears musical sounds, the perception is dominantly auditory, and while various other sense experiences may be *suggested* by the sound, no one of them is in any way so vivid as the auditory. But for certain persons the sounds produce forthwith a consciousness of color. The colors are sometimes of sensory vividness. More often they resemble imagery in texture. But they come instantly and blend with the sounds, and are native, not acquired. Moreover, they are substantially constant, the same shades

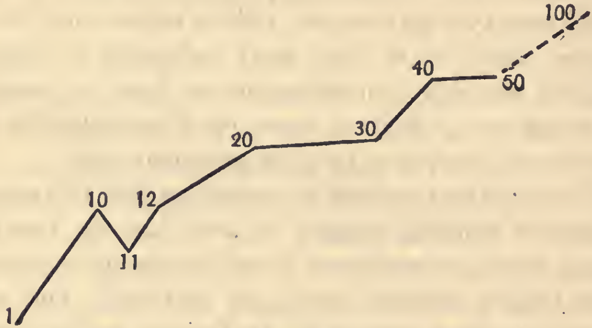


FIG. 49.

always occurring with the same tones or words. The auditory-visual synaesthesias are the most frequent, but other senses are sometimes involved, particularly taste.

Number Forms.—The second peculiarity has no single name but is illustrated by the so-called 'number forms.' Sir Francis Galton gives a most entertaining and instructive account of them and of the synaesthesias in his *Inquiries into Human Faculty.* The number form is a graphic *mental* picture (see Fig. 49) used by its possessor to exhibit numerical relations. The numbers are mentally projected in a sort of visual frame and are *always thought*

of in this way. The months of the year are often placed in such forms, although of quite different shape, and many other instances of the same tendency might be cited. The number forms, however, by their amazing variety, intricacy, and early appearance in childhood present the appearance of being natural phenomena, not invented or consciously adopted, while most of the others suggest artificial invention for amusement, the adoption of forms actually seen, or perhaps involve an effort to render *concrete* in visual form, something abstract not to be otherwise so easily memorized.

CHAPTER X

REASONING

Having analyzed separately and in some detail several of the main divisions of adjustive mental processes, e.g., sensation, perception, memory, and imagination, we must now examine the concrete processes of actual thinking, in which all of these are involved. Practical thinking is never comprised *merely* of memory processes or imaginings or perceivings taken singly. It implicates all of them in one way or another.

Adjustment as Problem Solving.—In the opening chapters of the book, we dwelt at some length upon the conception of organic life and intelligence as a process of adjustment. We must now return to that same conception and connect it with the process of thinking, which is another name for problem solving. We shall turn first to a scrutiny of certain typical forms of problems which confront us in ordinary life, and then inquire what are the usual varieties of conscious procedure in meeting and mastering such difficulties.

The earliest and the most persistent kinds of problems are connected with the immediate maintenance of life. In infancy the gratification of hunger and thirst are cared for almost wholly by reflex activities, which, thanks to parental supervision, make practically no tax upon the child's own intelligence. A little later, however, there present themselves great groups of problems connected with the control

of the bodily muscles. These are mastered by a slow process of 'trial and error' (or 'try, try again,') certain details of which we shall have occasion to discuss a little later in our account of the development of voluntary control. Passing over these achievements, we may come at once to the sort of problem which confronts the child after he has learned to walk and talk and exercise a reasonable control over his movements.

The earliest forms are undoubtedly those which involve the child's adjustment to his physical surroundings and to other human beings. He has to learn by actual experience the size and the weight of objects; to test his strength and endurance in terms of the resistance afforded by them; to learn their relations to one another. With human beings, he must master the intricacies of deportment, and must establish a nice discrimination for the prejudices of particular individuals in a position to punish or reward him for success or failure in complying with their demands. Problems of these kinds do not at the outset call for any very elaborate processes of reflection. Life is cast in a decidedly experimental mold for the child at this stage. He cannot predict what will occur, and he is thrown back upon an actual test, for the making of which he has abundant instinctive incentive.

The Primitive Tendency to Generalize.—The striking characteristic of the mental reaction of the child in this experimental process is his deeply rooted disposition to expect that both people and things will behave in the future as they have in the past. He is an incorrigible generalizer, and only the bitter fruits of experience teach him after a time to cultivate an attitude of skepticism, until his knowledge of both man and beast can be relied upon for purposes

of prediction. In this matter he is not unlike primitive man when full grown. It will cost generations of scientific training to breed out this disposition to generalize on inadequate data.

'Trial and Error' Method in Thinking.—Another striking feature of the early types of adjustive process is their strong tendency toward the relatively random 'trial and error' procedure. A little child confronted by a gate which will not open is very likely to react, much as a dog might, with violent assaults upon the impeding barrier and with little or no attempt to discover and relieve the precise difficulty. Even at a later stage, when the problems which present themselves are more definitely intellectual in character, there may be much of this same random trial and error method of arriving at conclusions. In any event, practically all the problems of early childhood present themselves as relatively simple, concrete issues, such as a particular cake to be secured, a particular door to be opened, a particular parent to be cajoled. The solution is in turn apt to be some relatively simple concrete act; and the trick is to discover it. In familiar situations, the answer may be given almost instantly after the nature of the problem is recognized. In other cases there is nothing for it but to try now this and now that solution which may suggest itself. There may be little or no attempt to weigh the probable success or failure of any of the suggestions in advance of an actual test.

The result of this type of thinking is apt to be the acceptance, as a permanent mode of procedure, of the first solution that comes to hand. This may by accident be the best solution, but more often it is not, and thus it comes about that in carrying out a definite reaction, the child, like an

animal, may incorporate and maintain in it many quite useless elements. In learning to write, for example, which is a type of process usually carried out under instruction, and therefore under conditions much more favorable than those we have been discussing, children maintain indefinitely quite needless contortions of face and limb, contributing nothing at all to the elegance or effectiveness of their chirography.

Conception and the Analysis of the Problem.—In all the cases thus far mentioned, we have assumed that the problem which the child has to face is more or less imposed upon him by the circumstances of the situation. Such problems are caused by the appearance of any obstacles in the path which he is following, and whether physical or mental, they disclose at once their essential nature. A little later, quite a different set of circumstances is encountered, in which it becomes necessary first to determine with exactness the *real character* of the problem which is to be solved, and thereupon to proceed to its solution. Social life is full of experiences of this kind. One becomes aware that for some undefined reason things are not going well. Before the cure can be applied, one must analyze the situation and determine, if possible, at what point the difficulty is located. In many types of scientific problem the same situation is encountered, and before one can move toward a solution, one must first make sure of the real nature of the trouble.

This identification of the character of the difficulty plainly consists in connecting it with some previous and familiar experience. Psychologists speak of this process as 'conceiving' the situation in a particular way. In the case of many purely intellectual problems this description

is appropriate enough, but in cases where the situation is primarily one of sense perception, as in the inspection of a disabled machine where one wishes to discover the defect and repair it, the location of the difficulty may not seem so naturally to justify the term *conceiving*. Nevertheless the character of the process is at bottom essentially the same, and we may neglect such differences as arise between the wholly ideational and the partly perceptual forms.

Stages in Problem Solving.—To conceive aright the difficulty with which one is confronted is, then, in a thinking process, the first essential step toward a solution. In certain very simple types of problem, the solution may come almost immediately, as has been intimated in a preceding paragraph. For instance, a new door key fails to throw the lock. It occurs to us that possibly it should be withdrawn a trifle from the guard, whereupon it instantly works. In more complex problems (and these would be represented in almost all the more serious reflective forms of thinking), the correct conception of the difficulty (which may itself be secured only after much effort) leads at once by the process of association, to a survey of one after another of the ideas which are suggested as possible solutions. The thought process, then, which has commonly been called *reasoning*, involves as its first two stages (a) the correct concept of the problem or difficulty, and (b) the securing, by means of association, of an idea which will meet the difficulty. Evidently the thought which gives us the solution may come only after a long process, in which many ideas offer themselves and are turned away as ineffective. This process of selection and rejection rests upon a psychological activity which psychologists have generally designated *judgment*.

A final step which is involved in an entirely complete process of reasoning is known as proof, and consists in the organization of one's evidence in such fashion as to establish the correctness of the solution upon which one has pitched. We shall comment upon certain phases of this matter a little later in the chapter. Let us return for a moment to consider the first two stages which are peculiar to every *bona fide* thinking process.

The Nature of the Concept.—If we stop a thought process and examine that part of it in which we are confronted with a concept, we shall find that commonly this consists in some significant image or group of images. If, for instance, in a geometrical problem, one has occasion to use the concept 'triangle,' many persons will find that there arises in the mind a more or less distinct visual image of a triangle, which serves in the thought process to represent the relations peculiar to that special geometrical form. Other kinds of objects or relations may also be conceptually symbolized by other forms of visual imagery. But undoubtedly far the most frequent type of imagery employed for thought processes is linguistic. Such images may be auditory or visual or motor, and the apparently motor forms may in fact be actual, though partly suppressed, enunciations, and not real images at all. The special sensorial form is entirely indifferent, but the use of words as thought material is by no means indifferent, as a moment's consideration will clearly disclose.

Words as the Material of Thought.—In the first place, the word, in distinction from the object or the relation to which it refers, is relatively free from the limitations of particularity. It can be used to cover any one of dozens of particular instances without prejudice to its accuracy.

The word dog, for example, is as applicable to the Newfoundland as to the poodle, to the terrier as to the hound, to the dog seen today as to the one seen a year ago. Consequently the word image 'dog' (whatever sensorial form it appears in) is measurably free from any disturbing limitations of particular animals or particular times and places. If one wishes, therefore, to have a thought symbol which may be used with great freedom as a general term, the advantages of the linguistic form over others are evident. A moment's reflection will also make clear that just this kind of generality in a concept is of the utmost value in thinking. It serves to represent the essential features common to all the objects, or all the relations, of a class in a way which no single instance of either the objects or relations could so conveniently give. There is no difficulty in attaching any desired particularity to a linguistic image by the use of other modifying word-forms—adjectives, adverbs, and the like.

Again, the fact that communication between men goes on chiefly in the form of words has an important bearing on the matter. To be sure gestures, of which spoken words are the most highly developed form, are also employed for this purpose, as they are among animals. By using language as the material of thought we carry on our individual thinking in the same medium which we use to communicate our ideas to others. Were this not the case we should have to translate our thought back and forth from one medium to the other. We should be obliged, as it were, to make constant use of two *languages,* one for thinking and one for communicating. When we remark the overwhelming preponderance of social interests and social relations in our lives, the advantage of the use of a single medium

for both of these purposes is obvious. Indeed, some psychologists maintain that the thought process arises out of social situations and would not otherwise appear.

Other Materials of Thought.—Many people apparently make large use of motor attitudes and images for handling these conceptual situations. To persons whose thinking is not cast in such terms, it is hard to make clear in just what materials such thought goes forward. But to revert to the illustration of the triangle, persons of the motor type would, instead of employing either visual or verbal material, find themselves tending perhaps to make the movements of the hand necessary to trace the triangle, or similarly tending to follow with nascent movements of the head or eyes the outlines of the form.

In any case, those forms of imagery (visual, auditory, motor, etc.,) natural to the individual tend to dominate his method of thought. Experiments have shown with essential conclusiveness that an individual may use one type of imagery for one kind of problem, and quite another type for problems of a different sort. The writer, for example, in trying to solve a geometrical problem without the use of pencil and paper inevitably falls back upon visual imagery, constructing in his mind just such figures as he would actually draw if the materials were at hand. But in dealing with a problem involving consideration of some academic issue, e.g., the point at which modern languages may best be introduced into the school curriculum, his thinking would tend to take the form of auditory-motor language imagery. There would be a sort of mental debate carried on. Peculiarities of this kind will serve to illustrate the difficulty of making any sweeping statement about

the predominance in a given mind of any one kind of imagery.

In actual thinking, our ideas are apt to move forward so rapidly that it is often difficult to be sure what forms of thought material are being used. But a little introspective practice will readily identify them, especially if one select for examination processes in which one is dealing with very difficult issues where the progress is slow.

Non-Conscious Elements in Problem Solving.—It may perhaps be mentioned at this point that a highly important part of many thinking processes is in no proper sense conscious at all, but is cerebralistic, or physiological. This applies perhaps more to the stage of the mental operations next to be mentioned, but it is measurably true of them all. To illustrate, one is suddenly confronted by a difficult problem, and one says: "Let me think a moment"; whereupon the brow is wrinkled, the breathing is checked, and all the external symptoms are those of profound abstraction, one may even say that one is 'thinking hard.' During the whole process, so far as concerns any strictly conscious process, the mind may have been essentially a blank, a mere vacuum; and yet at the expiration of a moment or two one may give utterance to a perfectly sane solution of the problem, or there may come into the mind a group of ideas satisfactorily meeting the difficulty for which one then seeks appropriate expression. This kind of non-conscious thinking has probably led certain psychologists to the belief in what they call 'imageless thought.' There is no objection to this phrase, provided it be not interpreted as meaning that we have a form of *awareness* of *meanings* which is entirely devoid either of imaginal or of sensory bases. The present writer does not believe that there is any convincing

evidence of this type of thing, whereas the subconscious brain process is frequently responsible for the solution of difficulties. Such solutions are reached both when asleep and when awake.

The extent to which thought is really carried on in unconscious form is a subject of wide disagreement. But not a few of our ablest psychologists are disposed to urge not only that some of our thinking is unconscious, but also that practically all of it which is fundamentally significant goes on in this way. It is easy for anyone who speaks readily to gain convincing evidence that the particular words used to express a thought were often in no way mentally anticipated just prior to their actual use. The field of pathological phenomena is full of instances tending to suggest the same general conclusion, i.e., that large parts of our so-called thought processes are in no proper sense definitely conscious.

The Use of Relations, Especially Similarity, in Thinking.—Arrived at the second stage in our reflective operations, and assuming that a satisfactory concept of the problems has been formed, we revert to the associative mechanism by means of which the conceptual imagery brings before us ideas to be scrutinized and tested as solutions of the problem confronting us. This is the point at which the supreme value of similarity is encountered. If we were confined to the use merely of ideas suggested by contiguity in previous time and place, the solution of any given problem would depend solely upon whether or not our own past experience had chanced to anticipate this special difficulty, so that the reëxcitement of the previously associated ideas might serve as a solution in the present instance. Thanks to the use of similarity, as between either

objects or relations, we are, however, enabled to transcend these limitations of particular time and place and to draw upon the entire resources of our previous life, without regard to any special space and time sequences. This similarity link (covering many forms of relations) enables us by an essentially creative process to bring into context with one another portions of experiences separated by months and even years of time, and thus permits us to make them supplement one another in the solution of our difficulties.

In simple problems, as has been mentioned, the mere appearance of the crucial idea may carry with it a satisfactory solution. This would be true, for example, in any problem, such as that of certain puzzles, where the solution consists in the discovery of a particular word. But in other problems, there is often need for the selection of first one and then another idea and the combining of these into a significant whole, comprising the complete solution. This type of thing is represented in many mathematical problems, and in many economic and political issues, where a considerable group of factors and their mutual relations to one another must be kept in mind. In other words, there is not only need in a complicated reasoning process for ready, profuse, and subtle associations, but a continuous process of selection and rejection is also indispensable until the finally successful combination is achieved.

There is no royal road to success in this matter, no ready-made rules which can be learned and applied forthwith. Practice within a given field undoubtedly produces a certain skill, but unless one's experience furnishes the requisite ideas, there can be no solution of the problem; and even if the ideas are available, for successful thinking there must be a certain dextrous control of the processes of

choosing and rejecting. Otherwise the thought will be cumbrous and ineffective.

The Habit Element in Thought.—Thus far, our analysis has been couched in terms which suggest the solving of particular problems without regard to their bearing upon further problematic situations. As a matter of fact, in the adjustive processes of the simple organism, to which the reader's attention was directed in the opening chapters of the book, as well as in the more complicated thought of human beings, the formation of *habits* of response is constantly in process. In the thought process this fact of habit is reflected partly in the concept and partly in certain 'general principles' of which we make use.

Attention was called at an earlier point to the intrinsic organic tendency to repeat on the second presentation of a stimulus the reaction made on its first appearance, provided this reaction had been satisfactory. This was spoken of as resulting in a *generalizing tendency,* and while there are no doubt exceptions, there is also no doubt that this is the usual rule. The concept may be regarded as the generalized form of a *psychological* reaction, and as such it tends in its turn to lead to a definite form of *motor* response. The concept *table* serves as a cue to a generalized type of motor adjustment. It represents for us an object in whose presence, regardless of any trifling individual peculiarities, we can do certain standard things, e.g., write upon it, serve food upon it, etc. The concepts of all common classes of objects render us similar service, and the same thing is true of the concepts of the more familiar relations, such as those of time and space. The concept *above,* the concept *below,* both stand for certain kinds of motor adjustment. The concept *earlier* or the

concept *later* similarly stand for a certain temporal arrangement of our behavior. In general it may be said that, although primarily *psychological* so far as concerns the medium in which they exist, concepts are *bona fide* habits and tend to express themselves eventually in motor forms.

The same thing is true of *general principles,* e.g., water will not rise above its source, men are stronger than women, etc. Indeed, the general principle is really little more than a concept expanded by verbal means into a formula for conduct. Thus, the principle in accordance with which, in a process of multiplication, one carries forward toward the left all but the right-hand digit in each partial product, is obviously a rule of procedure which rests upon the conception of the process of multiplying. The general principle which formulates the observed rotation of planetary bodies in elliptical orbits is again an expression of a mode of procedure which could be called a concept almost as well as a general principle. Similarly the principle of gravity formulates the behavior of bodies in their mass relations to one another in a fashion which could as appropriately be designated a concept as a general principle. Many instances might be cited of the use of general principles, taking them either from the range of science or of practical life, but in each case we should find the same thing true.

Following the example set by writers on logic, psychologists have been wont in connection with their analyses of reasoning to give some attention to the two processes known respectively as induction and deduction. Without attempting to enter with any detail upon the problems thus presented, we may venture a few brief comments.

Inductive Thinking.—Induction is a name for the

process by which we arrive at such general principles as those which we have just mentioned. The result, when attained, evidently has the value of a 'habit' of thought or behavior, which we are then able to use much as we do our motor habits, in a more or less automatic way, and at least without serious reflection. Thus, in thinking about the behavior of physical objects, we do not find it necessary to stop and speculate upon the tendency of unsuspended masses to fall to the surface of the earth. This habit of theirs, which we refer to gravity, we take for granted whenever occasion demands.

There are various ways in which we come into possession of these general principles. (1) Many of them are supplied to us by our elders, or by books, in the process of our formal education. (2) Others we come gradually to acquire for ourselves in a sort of rough-and-tumble mental process well represented in the harsher experiences of life. Without any special reflection on the subject, we learn in this way that hot objects will burn, that sharp ones will cut, and that smooth ones are agreeable to the touch. These experiences we convert more or less promptly into generalized motor reactions as we have previously indicated, and at the same time we are very apt to translate them directly into intellectual terms as principles to be used when needed in our thinking.

(3) Differing from both these methods is another peculiar to the more abstract generalizations of the sciences. These are based upon much more elaborate trains of thought and upon much subtler inferences. The whole process involves a more *specific purpose* to formulate and *justify* the principles involved, than is the case in either of the first two methods by which we achieve generalizations. Darwin's

establishment of the evolutionary hypothesis in regard to organic life may serve as an illustration of this higher form of generalization. It would take us too far into logical considerations to attempt to explain the various grounds on which the validity of scientific inductive inferences has been based and we must pass on to other matters.

Deduction.—Over against induction which represents broadly the process of *habit formation* in the region of thinking, stands deduction, which represents the *application* of *habits already established.* After we have formulated and demonstrated such a general principle as that of gravity, we can at once infer deductively the behavior of any specific set of masses under specific conditions. A very large part of our practical thinking is directed to determining the particular principle or concept under which a specific instance is to be brought. When this is determined, the consequences follow almost automatically. Nowhere, perhaps, is this type of procedure more frequently met with than in the case of moral issues. Here we often find it difficult to classify a particular act. Once we can be perfectly clear that it is to be put under such a heading as 'lying' or 'stealing,' the practical consequences for our thinking or our conduct immediately follow. But until we are certain what classification to apply, our thought is held in suspense.

Combination of Induction and Deduction in Practical Thinking.—It is a common misapprehension to suppose that our thinking is either exclusively inductive or exclusively deductive. In actual fact, practical thinking commonly involves both types of process in somewhat intimate admixture. We make use of general principles and we set about the forming of new ones all in the course of the

attempt to solve a particular problem. This does not mean that we are overtly conscious of the intention to apply a general principle or to create a new one, but simply that in dealing with practical issues we do, in point of fact, carry on parts of our thinking by way of applying concepts and general principles, and other parts of it in such a fashion as to create the beginning of a new general principle, or a new conception. This fact will be readily enough appreciated if it is compared with the corresponding motor situation, where in making use of an already acquired habit like writing, we employ it to deal with a fresh problem. In so far as we solve this, we gain possession to some extent of a new capacity, which we can in turn at a later time employ more or less in the *habitual* way.

The Reasoning Powers of Animals.—In concluding this chapter, a few words upon the reasoning powers of brutes may be of interest. The writers of a generation ago were disposed to contrast instinct with reasoning as two radically distinct and essentially opposed characteristics. Sometimes they urged that brutes were guided solely by instinct, whereas man, although at times under the domination of instinct, was chiefly controlled by motives of a rational kind. Always, however, there have been portrayers of animal behavior who insisted that wild animals in particular, but all animals to some extent, made use of processes essentially like those of human reason. Few neighborhoods are wholly free of dogs or cats, which, if their owners may be believed, evince at times all but superhuman intelligence. To be sure, these Nietszchean super-brutes have rarely been caught in the act by critical outsiders, but their conduct soon passes into a neighborhood myth and is accepted more or less uncritically at its face value.

It has been the ungracious duty of contemporary experimental observation to strip from the brute world most of the anecdotal laurels which the previous generation had accorded. When subjected to thorough-going scientific observation under controlled conditions, it becomes quite certain that whatever may be true of the occasional genius among animals, at least the rank and file of those lower in type than the apes solve their problems by methods which are in no sense identical with those of reflective human thought.

The common method of conducting such experiments is to place the animal in a situation which requires it to solve some simple problem appropriate to its supposed capacities and as closely as possible simulating the conditions with which it has to cope in its natural habitat. This problem is generally so arranged as to have the securing of food hinge upon its solution. This would mean, for example, that rats and mice would be obliged to find their way through a tortuous set of paths to their food which they could not see, but the odor of which could readily reach them. Animals of all degrees of complexity, from the very simple marine animals, like amphioxus, up to the higher quadrupeds and the anthropoid apes, including on the way both reptiles and birds, have been subjected to experimental investigation.

A wholly unexpected wealth of new information has been accumulated as the result of studies of this kind, and our knowledge of animal instinct and of many features of animal behavior has been immeasurably enlarged. But at no point have we come upon conclusive evidence that animals can in any definite way abstract the essential point in a problem and then bring to bear upon it in the mind

the fruits of experience, as can a human being. Under experimental conditions at least the animal method of solving a practical difficulty is substantially that of blind trial and error. All kinds of violent movements are made; the animal runs hither and yon, attacks the apparatus here, there, and elsewhere, and finally, as the result merely of its exuberant muscular activities, it succeeds in stumbling upon the solution. In a human being, even though the problem were solved the first time in some such manner, the chances are that the solution could be repeated a second time almost immediately. But not so with the animal. The second trial may be somewhat shorter, or it may be longer. In either case the ability to reach a solution with certainty requires many repetitions and a considerable period of time. In other words, the animal gives no evidence of really *comprehending the relation* between the end to be reached and the several steps necessary to attain it.

It would be too broad a statement to say that animals never perceive relations. Indeed, it is no doubt dangerous to make any sweeping statement without distinguishing the different genera and species from one another. For it goes without saying that the adaptive intelligence of the higher apes and of some of the other mammals, like the elephant, is far higher than that of the reptilian and cretaceous forms. But after making due allowance for these differences inside the brute kingdom, it still remains true that in his ability to analyze, to abstract, and to generalize, and especially in his power to use language as an accessory to all these processes, man so far excels the animals as to render his behavior in many important particulars essentially different from theirs. Of course one does not mean in a statement of this kind to urge any radical *discon-*

tinuity of development between the higher animals and man, because the human child gives abundant evidence in its earlier years of behavior which is substantially identical with that of the animals. But one can allege that, considering behavior as an expression of intelligence, the evolutionary break between man and the animals is far greater than would be suggested by a casual observation of their anatomical organization. To be sure, the human brain differs in important particulars from even the most highly developed animal brain. But the differences are not such as would ever have suggested the gross disparities in intelligence, which the study of behavior clearly discloses.

CHAPTER XI

FEELING

Simple Feelings.—In our descriptions thus far of the adjustive processes of intelligence, we have emphasized the *sensations* by means of which we come into contact with the world of physical objects and the *ideas* which serve to represent these sensorial experiences when the originals are not present. This procedure has involved a temporary neglect of another group of factors of which mention was made at the outset, and to which we must now return. Psychologists often refer to these as simple feelings, and although there are some serious objections to the term, it is perhaps as convenient as any other, and may for the time being, at least, be employed.

When a stimulus falls upon a sense organ, it normally sets up a nervous excitation which is then transmitted into the central nervous system, whence it issues again as a muscular movement. But it is apt to occasion other consequences besides those thus described. It is likely immediately to produce either pleasurable or painful results. A sound thus striking upon the ear may be sensed as agreeable or as disagreeable. Secondarily, the movement to which it gives rise may be followed by a subsequent group of sensations, in their turn agreeable or disagreeable. Thus, a visual object stimulates the retina, and the hand is extended to grasp it. If it be a thistle, or a burr, the disagreeable consequences are likely to be extremely vivid. Thus it

comes about that from the very beginning sensory stimulations are for the most part not indifferent, but already come freighted with prejudices, favorable or unfavorable, to their repetition.

In the life of the lower types of animals, and in the experience of the human child, these psychological factors apparently play an extremely important part, and they must therefore be examined with some care. In adult human life, they become complicated with many other influences, so that the immediacy of their operation is screened or lost. The little child or the animal will unhesitatingly seek to repeat the pleasurable stimulation as long as it remains agreeable, and will similarly shrink from the painful stimulus. The adult human being, on the other hand, has learned that it is the part of wisdom to curtail the repetition of pleasurable experiences before satiety has been reached. He has also learned that the endurance of many forms of painful stimulation may be the price of more lasting or more satisfying future pleasures. In other words, experience complicates enormously the implications of the pleasure-pain experiences of primitive life.

The Varieties of Simple Feeling.—Among recent writers there has been some divergence of opinion as to the number and character of these psychological elements. The great majority have recognized only pleasantness and unpleasantness (physical pain, as was pointed out in Chapter VI, which may itself be at times agreeable, though it is commonly disagreeable, is undoubtedly a sensation). The eminent German psychologist Wundt recognizes two other groups of elements, which he designates strain-relaxation and excitement-calm. These he thinks of as combining with one another in various ways, although only one member of

each pair would ever be present in a single moment of experience. The American philosopher and psychologist, Josiah Royce, excludes strain-relaxation but accepts the other two Wundtian groups. The present writer, for reasons which he feels it unnecessary to discuss in detail, is disposed to adhere to the older view, and to treat pleasantness and unpleasantness as the only elements substantially different from sensation. Indeed, in his judgment there is a good deal of evidence to suggest, as not a few modern writers are now urging, that even these forms of experience are themselves vague, diffused, organic sensations. Even if this last doctrine should finally become established, it would still be convenient to accord a separate discussion to these factors in our mental make-up.

Among other reasons, the view generally prevalent at present distinguishes from the sensations these two forms of simple feeling (1) psychologically, because they may attach themselves to *any* sensation or idea, and may vary independently, so that the same stimulus may on one occasion be felt as pleasurable and on another as unpleasurable; and (2) physiologically, because they are thought of as arising not from the stimulation of a particular sense organ with its connected chain of neurones, but as arising from the way in which the nervous system *as a whole* is affected by any momentary stimulation. The alleged fact that we do not localize them as we do sensations is urged in support of this view.[1]

[1] Of course if they prove finally to be sensations, they must depend upon special sensory nerves which must be capable through some physiological device of being reflexly excited from activities in the cerebrum, or in other parts of the central system. The possibility that the thalami are the central organs responsible for them would not be irreconcilable with this conception. See page 45.

Explanatory Theories of Feeling.—In connection with the physiological conception, two general types of hypothesis have been advanced. The first maintains that all experiences which are organically beneficial tend to elicit pleasure, whereas those which are physiologically harmful tend to occasion pain. The second is substantially a modification of the first, and urges that pleasurable experiences are such as involve activities of the nervous system well within the limits of its physical powers, whereas unpleasant experiences involve excessive drain at one point or another upon the resources of the system.

Another widely held view connects pleasure with mental activities which progress smoothly toward an end, and displeasure with such as are impeded or obstructed in their course. Obviously this conception is most immediately applicable to cases in which the mind is engaged in processes of problem-solving of a rather definite kind. In such instances, we become readily aware of differences in the ease and directness with which our thought attains its goal. For example, a student trying to study finds the interruption of a neighboring piano extremely disagreeable, even though the music itself be intrinsically pleasant. On the other hand, the very act of studying, provided the thought processes involved go forward smoothly and effectively, is likely to be found agreeably stimulating. In such a situation the theory mentioned would find an explanation for the appearance of agreeableness or disagreeableness in the absence or presence of material interruption to the thinking.

This type of theory finds it more difficult to give a satisfactory reason for the appearance of some forms of sensory pleasantness and unpleasantness. If one strikes a discord

on the piano, the effect may be markedly disagreeable, and when one suddenly shifts to a group of harmonious tones, the result is forthwith pleasing. In both cases one's purpose may have been to detect the qualities of the tones, and in this sense both processes go forward more or less successfully; nevertheless the one is disagreeable, the other agreeable. Similarly there are degrees of pressure, degrees of illumination, degrees of noise, which are always disagreeable. Clearly such cases occasion embarrassment to theories couched in the form of the one we are now discussing. Facts of this variety evidently lend themselves much more readily to description either in terms of the biological utility (negative or positive) of the stimulus, or in terms of the capacity of the sense organ and the nervous system to respond. Nevertheless, while one may refuse to accept a formulation of the kind under consideration as affording in any sense a complete theory of the conditions of feeling, one must frankly recognize that a very large part of the more important of our human experiences are correctly characterized by it.

One of the early formulations essentially similar to the one we are now examining connected pain and unpleasantness with a tendency to change whatever conditions obtained, and pleasure with a tendency to continue such conditions. This notion falls in very readily with the general biological hypothesis of agreeableness and disagreeableness as protective indices, the one indicating a need of instant fresh adjustment, the other endorsing whatever process is at the moment going forward.

A variant of this view identifies pleasure with expansive, appropriative movements, pain and displeasure with con-

tractive movements and movements of retreat. The formulation is roughly correct in its application to simple sensory pleasantness and unpleasantness, but cannot be pressed very far without breaking down.[1]

It must be frankly admitted that all these conceptions are in a measure speculative and that while they correspond to certain broad features of common experience, they are none of them free from difficulties, none of them affords wholly conclusive explanations of observed phenomena. It is hardly to be supposed that any species of animals could survive, which sought, rather than shunned, painful experiences, because in general such experiences are simply the conscious side of physiologically disastrous conditions. Any creature which gratuitously sought out the circumstances productive of headache, toothache, and earache could scarcely be expected to thrive. Clearly, too, a creature which was wholly oblivious to pleasurable experiences could hardly expect to secure the best conditions for its physical well-being, and in competition with other individuals and species would almost certainly be out-distanced. Whether pleasure and pain have, therefore, been prime factors in the development of animal behavior, it is at all events clear that they can hardly have failed to play an important part. On their lower levels, they certainly represent modes of guiding the organism in advance of the

[1] Wundt alleges that there are certain definite and constant changes in the respiration and circulation corresponding to his six simple feelings. Some other psychologists have reported such changes for pleasantness and unpleasantness. The present author regards the evidence upon which these views rest as open to grave doubt. Many competent experimenters have been unable to demonstrate any constancy in the connection of the affective mental states with the alleged physiological reactions.

lessons of experience and in advance of the development of critical intelligence.

Complex Feelings.—A distinction may now be drawn which logically should have been mentioned earlier, but which seemed likely to be somewhat more readily understood if postponed to this point in the chapter. This has to do with the difference between the *simple elements* of feeling, sometimes designated in the modern literature 'affection,' and the *complex feelings* which involve not only these elements but sensations and ideas beside. The simple feeling, or the 'affection,' is clearly gotten only by abstraction. We never experience pure agreeableness devoid of other conscious accompaniments. What we experience is always an agreeable idea, or an agreeable emotion, an agreeable memory, or an agreeable perception. It is perfectly possible for us to isolate the agreeableness in our retrospective analysis of any particular experience. Indeed, scientifically it is quite essential that we should do this, for an idea, emotion, memory, or perception may obviously be experienced either with an opposite feeling, or to all intents and purposes with no feeling at all. Thus it has come about that psychologists who use the word feeling as a technical term are disposed to apply it to the entire concrete experience in which agreeableness or disagreeableness is a conspicuous element, but in which other mental factors are also present. The terms simple feeling, affection, or feeling-tone, are then used to designate the special part of the process which is represented in its pleasantness, unpleasantness, and the like. (See Fig. 50.)

Strictly speaking one can hardly classify feelings except into such rudimentary groups as are already represented in our own acceptance of agreeableness and disagreeableness

as primordial distinctions. Despite this assertion, a good many classifications have, as a matter of fact, been proposed and adopted. One of the older of these distinguishes higher from lower feelings. In the application of this distinction, it appears that the lower feelings, so-called, are chiefly those connected with the immediate use of the senses most closely related to the nutritional processes (e.g., agreeable and disagreeable tastes and odors) and to those connected with the physical appetites and passions. The

Fig. 50.—To illustrate the relation of simple feeling to total feeling states. *SF*, may represent a simple feeling, or affection, like pleasantness, which may be combined with *Se*, sensory, or *I*, imaginal, or ideational, elements to constitute a total complex state of feeling.

higher feelings are on this showing such as have to do with moral, intellectual, and aesthetic experiences.

For some purposes a distinction of this kind undoubtedly has justification and value, but it may well be questioned whether it is not psychologically somewhat misleading. The pleasures and pains of taste and smell, for example, and those which are connected with the relief of hunger and thirst, may be thought of as lower than the pleasure and pains of moral experience, because it may seem that the latter have a more direct importance for society and the general character of human relations. But if, as we believe to be the case, the pleasure in the one instance is qualitatively of the same kind with the pleasure in the other, and

especially if we find ourselves obliged to admit a peculiarly rare and fine type of pleasure elicited by the fragrance of spring flowers, or by the play of beautiful colors upon the retina, we may begin to call in question not only the psychological value, but also the intrinsic truth of a distinction which sets over against one another facts that are, in their inner essence, of essentially the same order. We do not mean to assert for a moment that there are not in such cases abundant differences in the sensory and ideational settings of these simple feelings. We do mean, however, to urge strongly that intensity and duration apart, the agreeableness and the disagreeableness of one group of experiences is quite of a piece with that of the other.

Another classification ostensibly different from that just described, but in point of fact working out to a result in many particulars similar, recognizes a distinction between sensuous and ideational or intellectual feelings. The basis of this distinction is too obvious to require discussion, and like the one just examined, it clearly involves a division not based upon the feeling-tone or the 'affection' as such, but simply upon its cognitive accompaniment in the form of sensation or idea.

Again, one frequently encounters reference to personal feelings, to social feelings, to ethical and aesthetic feelings. All these divisions are perfectly legitimate, and all refer to groups of experiences which the exigencies of practical life, or of one and another of the philosophical sciences, have required that we should recognize. But to each and all, in so far as they are offered as psychological classifications, the same comment is appropriate. They are classifications either of the conditions under which certain sorts of complex feelings arise, or they are classifications of the

mental concomitants of our feeling-tones, rather than classifications of the feeling elements themselves. This entire problem presented by classification exhibits one of the essential characteristics of pure feeling, which may now be profitably mentioned.

Feeling, Sensation, and Attention.—It is exactly the vagueness and the undifferentiated character of feeling which sets it off from sensation and idea. So much so is this the case that it is commonly agreed by psychologists that we cannot in any proper sense attend to a feeling-tone. Certain it is that, if in the midst of an agreeable experience one attempts to fix attention upon the pleasantness as such, one forthwith finds that the whole experience has been transformed and the agreeableness has evaporated in the process. In order that we should be able to attend to any item of our experience, it is apparently essential that it should be possible to discriminate differences within it. This is exactly what we cannot do in the case of these elements of feeling-tone. They are apparently homogeneous, and while they connect themselves in the most varied fashion with all other psychological materials, they never themselves become focal. They are always, as it were, in the margin of consciousness. There we may observe them by a sort of mental indirect vision, and we are, in the moment of experience, keenly aware of their presence, but to make them the objects of attention is apparently to destroy them forthwith. They seem always to function as adjectives or adverbs, which demand a substantive or a verb of some kind to which they may attach.

This hostility of feeling-tone to attention has led some authorities to the interesting suggestion that attention and feeling-tone are really the two opposite sides of one and the

same process. This is perhaps another way of stating a much older doctrine, i.e., that sensations and ideas give us the objective elements of our experience which we can, if we will, share with others. By looking at the same object, we may both get what is practically the same sense perception, and we get this by a process of attending. Feeling, on the other hand, represents our purely individualistic experience, the way in which we subjectively react. This part of our experience we can in no immediate sense share with others. In any event, it is the purely unique individual part of the experience, which makes it mine rather than yours.

Feeling and Personal Attitude.—Whatever the final validity of such distinctions as those mentioned in the previous paragraph, it is unquestionably true in a broad, general way that feeling represents in a very real and peculiar sense the personal mental attitude of the individual. In what one feels much more truly than in what one thinks about, is revealed one's actual character and temperament. This is not equivalent to saying that a man's thought is in any way a matter of indifference in the formation of his character. It means simply that deeper and more significant than the items in one's body of knowledge, and even deeper than the particular content of one's thought, is the personal attitude toward all these ideas and their meaning.

Before leaving the specialized discussion of feeling, we may properly devote a few moments to a consideration of certain of its relations to the control of conduct.

Feeling and Conduct.—We indicated at the outset of the chapter that one important view is committed to the doctrine that feeling represents the primitive guide by

means of which conduct is steered away from harmful and toward beneficial types of reaction. So long as this doctrine is confined to the behavior of the simpler organisms whose environment is relatively simple, and whose activities are relatively stereotyped, it is likely to seem plausible enough. Certain it is that the observation of animals low in the scale of intelligence distinctly suggests reactions of a reasonably immediate kind in terms of the agreeableness or disagreeableness of the stimulus and the ensuing response. Fishes, for example, seem often to wander about somewhat aimlessly, rejecting whatever food is offensive and unhesitatingly accepting that which is appetizing, and in the meantime evincing little or no evidence of behavior controlled by ideas or any other kind of process involving foresight. If agreeable but poisonous food be offered, it is immediately accepted. Behavior on this level, then, suggests rather strongly that whether or not beneficial reactions are made because they are agreeable, there is at least a general parallelism between those types of behavior which are apparently satisfying and those which are biologically useful, with a corresponding parallelism between the disagreeable and the injurious.

If one adopts the implications of this general point of view and applies them forthwith to the higher ranges of human conduct, one instantly comes upon a doctrine substantially that of the ethical hedonist. Taken in its crudest form, this view maintains that our conduct is always controlled, directly or indirectly, by a regard for pleasure and pain such that we tend always to avoid the latter and seek the former. Of course, in facing the actual complexities of human behavior, it has to be recognized that we often endure a present pain for the sake of a future pleasure, but

only under the conviction that the expected pleasure will outweigh, either in intensity or permanency, the momentary pain.

It is possible so to formulate this position as to make its successful contradiction decidedly difficult. But human nature is generally very unwilling to accept such a description as accurate to the facts. Whether this unwillingness merely reflects a universal moral vanity, or whether it is really based upon a keener insight into the actual facts, it remains true that this view has never succeeded in securing any large following. Ethicists and psychologists alike have criticized it on the ground that if one is to describe the situation in terms of the actual motives that are consciously present to human beings, an explicit control by considerations of pleasure and pain is relatively rare. Certainly no tired mother, sitting up through the long hours of the night with a sick child, can for a moment be supposed to have her conduct controlled by any thought of the pleasure which she is getting from the act. Nor would it be fair to her actual mental processes to say that she is controlled by the pleasure which she hopes to experience as a result of her care when the child recovers. Such acts may be called instinctive, and in part no doubt they are such, but they are none the less voluntary, and so far as concerns their conscious motive, pleasure and pain as such are hardly ever in the horizon, except perhaps to be impatiently banished.

Between the two extremes of doctrine, the one tending to urge that pleasure and pain, if not the sole motives in voluntary behavior, are at least the dominant ones, the other regarding them as of no consequence, is perhaps to be found the real truth. It would surely be idle to main-

tain that pleasure and pain play no part in the early stages of our acquaintance with the physical world in which we live. That the burned child dreads the fire has become a text for hundreds of sermons designed to exploit the moral consequences of sin. On the other hand, the adage which teaches that to spare the rod is to spoil the child postulates the value of pain as an element in education of the formal kind. The entire modern doctrine of interest as essential in education and the abundant experiments exhibiting the dynamic effects upon children of approval and other pleasurable incentives, imply a widespread conviction that pleasurable experiences serve to energize and motivate conduct in some fashion or other.

It is of course absurd to suppose that agreeableness or disagreeableness merely as such are ever the direct objects of reflective choice, when we are deliberating about our lines of conduct. For one thing, it is generally agreed by psychologists that we have no power thus to summon from memory or imagination these pure disembodied affective elements. But on the other hand, it would be equally untrue to the facts to say that the expected agreeableness or disagreeableness of a line of conduct has no weight whatever in determining a decision. We may not formulate the decision to ourselves in terms that stress the consequences in feeling. Indeed, we may be more or less oblivious at the time to such consequences. But so closely knit is the fabric of our entire thought process that we could not without very special effort divorce from our thinking all influence of feeling.

Feeling and Voluntary Action.—It has been a common doctrine and is one for which so eminent a psychologist as Wundt stands sponsor, that voluntary actions always grow

out of feelings, or, expressed otherwise, that no volitional act ever occurs except in response to feeling. The particular formulation which Wundt offers connects acts of will with emotion, out of which he teaches that they always spring. The more familiar form of the doctrine implies that choice is determined by motives which in the last analysis go back to our feelings. Either of two possible lines of conduct may be perfectly rational and entirely defensible, but for the one we feel a strong predilection and toward the other a powerful aversion. Our choice rests, in such a case, not upon the sheer rationality of the act, but upon our feeling regarding the alternatives. While there may be decisions which are entirely cold-blooded and intellectualistic, and while many of our acts are essentially habitual and carried out without any particular reflection, there can be no doubt that in great ranges of our conduct such a description is correct, in that the psychologically moving factor which determines us to choose one rather than another course of action is to be stated in terms of our subjective prejudices and feelings, rather than in terms of pure reason.

CHAPTER XII

EMOTION

Feeling and Emotion.—Most familiar of all the forms of feelings are the emotions. Although this term 'emotion' is naturally somewhat loosely used in ordinary parlance, it applies in general to states of mind marked by some degree of excitement and commonly by the noticeable presence of pleasantness or unpleasantness. Despite the fact that these states of excitement tend to shade off into conditions of a relatively neutral kind, so that there is no sharp line to be drawn between emotional and non-emotional states, it is nevertheless profitable to devote some consideration to the more overt emotions which possess certain definite peculiarities tending to set them off with reasonable distinctness from other mental conditions. Anger, fear, hate, love, grief, embarrassment, may serve to suggest the more vivid and constant forms of emotion to which we shall now direct our attention. This group Professor James used to designate as the coarser emotions.

Emotion and Instinct.—The outstanding mark which characterizes these grosser emotions is their intimate connection with reflex and instinctive modes of behavior. Some writers have gone so far as to say that emotion is simply the psychological side of an instinct, it is what we feel when we perform certain kinds of instinctive acts. William James and the Danish psychologist Lange have given the most extreme formulations to this view. They

differ, to be sure, in some essential details, but the main contention which each makes is that in an emotional experience the characteristic features are contributed by changes in our consciousness brought about through certain movements which are made reflexly or instinctively. To bring the doctrine out in the most dramatic way, James puts the case by saying that "we feel sorry because we cry, angry because we strike, afraid because we tremble."

The James-Lange Theory of Emotion.—The common view of emotional expression has generally held that the clenching of the fist and the distortion of the face in anger are the results of the previously existing emotion. The theory to which we are now referring admits, of course, that these muscular movements are in a perfectly real sense expressions of the emotions, but it maintains that if these and all the other motor and glandular expressions are eliminated everything which is most characteristic of the specific feeling of anger at once disappears. The actual performance of the experiment which this suggests is obviously difficult, because in emotions of the violent kind, like rage and anger, many of the most important muscular movements, such as those of the heart and diaphragm, are not under voluntary control. Defenders of this doctrine maintain that one may have an entirely lucid apprehension of a situation as one justifying anger, but that the *emotion* is only *felt* when some or all of the instinctive muscular movements are made. These comprise among others—in the case of anger—violent tension of most of the voluntary muscles, particularly those of the hands, arms, and chest, changes in the tonicity of the blood vessels, by virtue of which the face often becomes scarlet, changes in the power and rate of the heart-beat, and profound alterations in the

breathing. Many other consequences affecting both the muscular and glandular system might be mentioned, but these illustrations will suffice.

Each of these movements sets up sensory changes, many of them accompanied by changes in the feeling-tone, and the sum total of these disturbances constitutes the peculiarly emotional part of the experience. If one looks at a bear behind the bars of its cage in the zoological garden, the experience may be wholly lacking in any particular emotional color. But the same bear, inspected at the same distance without the intervening bars, elicits a great group of these instinctive reactions, which, fusing with the perception of the animal, constitute the emotion of fear.

The particular group of motor reactions which are thus called out by emotional objects are native and inherited, not acquired. No one has to be taught how to behave when afraid, when angry, when embarrassed, or when in the power of any of these commoner emotions. Every child shows himself from the beginning a passed master in the expressions of anger, for example. These performances are, therefore, fairly to be regarded as instinctive, and it is the modification of our consciousness brought about by these untaught and unlearned motor activities, which in the view of the James-Lange doctrine constitutes the essential mark of emotion. The reader will readily infer, in the light of our previous analysis of memory, that individual experience will tend to emphasize many of these native reactions. The original expression of fear or of anger is, in the nature of the case, an entirely unique experience; but after one has been subjected to the emotion a number of times, one naturally learns what to expect, and the effect of one's memories of previous similar situations may enter

to give tone to a situation which does not itself call out in any complete way the full catalogue of natural responses.[1]

No one doubts that these grosser emotions possess characteristic motor accompaniments commonly called their expressions. The real point under debate is, therefore, whether the emotional feeling is entirely prior to and independent of changes in the field of consciousness occasioned by the movements, or whether these changes so elicited constitute, as James and Lange maintain, the essence of emotion as distinguished from non-emotional states. The racially hereditary or instinctive nature of the responses is not in question.

Stimuli to Emotions.—The original emotional stimulus is, of course, sensory, e.g., something we see, or touch. But it soon comes about, as a result of the development of memory and the ideational processes, that thoughts call out emotional reactions as vividly and as readily as do sense perceptions. The thought of an insulting remark may elicit quite as violent a reaction of anger or shame as did the original experience. Moreover, an emotional reaction may

[1] There has been some disposition to attack the validity of this theory on the ground of certain physiological experiments, part of which tend to show an intimate inter-relation between emotion of the fear-anger type and certain glandular activities, particularly those of the adrenals. The other line of criticism is based upon experiments on dogs, where the brain was prevented by operation from receiving incoming impulses from nearly all the viscera and from the surfaces of the body lower than the head region. In this case the behavior of the animals seemed to suggest relatively little change in the emotions named. This is not the place to enter upon any attempt to consider these contributions in detail. It is not the view of the writer that the criticisms are valid as against the main points of the theory under discussion. See an article by the author in the *Psychological Review*, Vol. XXIII, 1916, p. 251.

readily be transposed from one sensory stimulus to another, as when a child learns to associate the sight of his bottle with the satisfaction of his hunger and the taste of the milk. Just how far we inherit a disposition to react in the emotional way to *specific kinds* of stimuli is not altogether clear.[1] But it is clear that however various the stimulations which produce emotions, the motor and glandular reactions are relatively fixed. It is sometimes alleged, for example, that babies are naturally afraid of darkness and of fur. Neither of these reactions seems to be at all universal, but there is some evidence to indicate that one or both are represented in the case of certain children. Certain it is that when a stimulus is encountered that calls forth fear, the child's response is of the instinctive and fairly stereotyped form.

Organic Changes in Emotion.—Dr. Cannon and others have shown that in violent emotions like fear and anger, certain important substances are thrown into the blood stream by the ductless glands of the body. Adrenalin, the secretion of the adrenal gland, affords a striking illustration of this fact. This substance markedly diminishes the effects of fatigue in the muscles, makes the blood coagulate more rapidly and in general adapts the organism to put forth its maximal efforts. Similarly, an increased amount of sugar is secreted by the liver, thus furnishing the organism more fuel than usual. These discoveries all indicate that in emotion the organism enters upon a condition of

[1] Watson in an unpublished paper has tentatively reported three primitive emotional reactions and their stimuli as follows: (1) anger—stimulus—any constriction of free movement; (2) fear—stimulus—removal of bodily support, possibly loud sounds; (3) affectionate feeling—stimulus—gentle stroking or tickling.

excitability notably different from the normal state. Some of our "behaviorists" look forward to the day when we can classify the different emotions in terms of the glandular products thus introduced into the blood. Whether this result be attained or not, the facts already in hand exhibit the remarkable degree to which emotions are bound up with organic reflexes both of gland and muscle.

Ideational Element in Emotion.—In emphasizing the instinctive and the motor aspects of emotion, it must not be understood that we intend in any way to overlook the ideational parts of the process. These are of the utmost moment, and they become increasingly so as mental life evolves. Mental disease apart, one does not have undirected fear *in general,* impersonal anger or embarrassment *in general.* One is afraid of a *particular* object or situation, one is angry at a *special* individual or group, one is embarrassed by a *particular* situation. In all these instances one's intellectual apprehension of the circumstances, together with the various thoughts suggested in each instance, enter to determine the sum total of the emotional state. Even in the simplest instances this intellectual appreciation is momentous. To revert to an earlier illustration: the bear, which is an object of amused interest in the one case, an object of horrified fear in the other, may be, as a sheer matter of visual sensation, one and the same. Only when he is apprehended as a potential source of great bodily suffering does he become an emotional stimulus to fear.

The intellectual element in emotion tends to become more conspicuous as we pass from the coarser to the finer forms of emotional experience. In the range of aesthetic appreciation, for example, there is likely to be distinctly less

evidence of a purely bodily resonance, with relatively more of the subtle forms of intellectual pleasure. At no point, however, where we can properly speak of emotion, is this cognitive element wholly lacking. Emotion is therefore a highly complex condition in which sensations, ideas, and affections are intricately combined.

Emotion a Phenomenon of Interrupted Mental Activity.—The intensity of emotional experiences, as contrasted with other experiences, may perhaps be connected with the fact of interruption to on-going processes. Professor Dewey has defended the thesis that emotions are primarily called out when two instinctive tendencies are in competition for expression. Whatever judgment may be passed upon this particular view, there can be no doubt that all the more violent emotions are incidents of vigorous interruption to the ordinary flow of mental life. The stimulus which calls forth anger is typically one which blocks or thwarts our momentary activity. The same thing may be said of fear, and in general the onset of an emotion is marked by the invasion and dislocation of whatever processes are at the moment going on. In the joyful emotions this momentary interruption may be succeeded by a torrential flow of delicious excitement.

Darwin's View of Emotion.—In connection with the general view of emotion which we have presented, it may be of interest to mention briefly certain theories of Charles Darwin about the origin of our emotional responses. The reader will, of course, bear in mind the fact that as a rule Darwin's views rest on the doctrine that bodily structures, as well as the forms of behavior, represent the survivals of the fittest in the struggle for existence of millions of generations of ancestors. This conception naturally raises

the question as to the utility of our present equipment of instinctive reactions, some of which, like trembling when upon a high place, seem peculiarly incpt and disadvantageous. Without going into complete details, one or two of the Darwinian views may be mentioned.

There is first the contention that many of the forms of reaction now encountered were useful at a previous period of racial history. The stock illustration of this sort of thing is the elevation of the upper lip in scorn or in anger, a performance which has now no particular utility, but which in social conditions of a franker and less restrained character obviously may have been highly useful. A second doctrine involves the so-called principle of 'antithesis.' The savage attitudes of an angry dog obviously have a certain utility. Over against these, as the expression of affectionate moods, are an exactly opposite group. The theory here implies not so much the utility of the second group, as its appearance because it represents most nearly a complete set of muscular opposites to the contrasting emotional state. It cannot be said that the Darwinian explanations have at all completely solved the riddle of certain of our emotional reactions, but they will at least serve to suggest the lines along which it may perhaps be found finally possible to render intelligible some of the responses which now perplex us.

Classification of Emotions.—Many classifications of emotion have been suggested, but none has succeeded in winning permanent general favor. That which seems on the whole most fundamental involves a division into those which are historically primary, and those which are derived or secondary. Were we in a position to apply this principle of classification confidently, it would presumably

satisfy all essential needs. We are, however, obliged to use it subject to appreciable uncertainty regarding the dividing line which it attempts to employ.

It seems safe to regard such emotions as anger (offensive) and fear (defensive) as unequivocally primary. Presumably there should be also recognized something corresponding to love or affection in a broad, general sense. Superposed upon these foundations are such emotions as gratitude, sympathy in many of its forms, remorse, and pity. Each of these last-named experiences has obvious elements of instinct in it, and with the possible exception of remorse, each of them finds some representation in animal behavior. But as contrasted with the members of the first group it is fairly clear that they depend for their content upon elements which obviously grow out of experience. They are therefore in a reasonable sense to be regarded as secondary and to some extent derived. Presumably they involve one or another of the elements of the primary group.

Mood, Temperament, Sentiment.—Side by side with emotion we must put the facts of sentiment, mood, and temperament, for they are all inter-related phenomena.

The term emotion is usually applied to a relatively brief experience whose beginning and end can be fairly marked off. Mood is a term which we apply to a comparatively permanent emotional condition. One may thus be cheerful throughout a considerable period of time. This means that while such a mood endures, one is susceptible chiefly to those emotions which are closely related to the mood.

The term temperament is somewhat loosely used to apply to still more enduring emotional dispositions, but with some reference also to intellectual habits and motor traits.

The familiar division of temperaments into sanguine, choleric, melancholic, and phlegmatic has no very fundamental psychological basis, but serves roughly to characterize certain gross differences in individual make-up. "The sanguine and choleric types are alert and easily stirred, the latter displaying a more intense, the former a feebler, interest. The melancholic and phlegmatic types are slow in response, the former evincing a strong and vivid interest when once aroused, the latter manifesting a persistent but weak interest." It will naturally be understood that there are considerable variations in individuals, even when they conform roughly to these general lines of distinction. Moreover, there are all kinds of individual differences in intellectual equipment, affecting memory, imagination, attention, etc., which must be recognized in any general estimate of temperamental peculiarities.

While we commonly think of disposition as being dependent upon the prevalent emotional attitude, so that one is likely to be good-natured who temperamentally responds to most situations with emotions of the buoyant and more or less humorous type, it is equally true that emotions are likely to be affected by dominant trains of thought. At this point what we call sentiment, i.e., a relatively permanent disposition or attitude, is of prime consequence. Persons whose thinking tends to dwell upon abstract and theoretical subjects are likely to be lacking in sensitiveness to social and personal situations. They may be of an entirely kindly character when such matters are brought forcefully to their notice, but they are not naturally alert to their appeal. On the other hand, persons whose thought tends to dwell upon the persistent underlying problems of social organization are apt to be emotionally responsive to

human distress. When we designate particular individuals as sentimental, we mean to imply an exaggeration of this permanent emotional mood in one direction or another. There is an essentially reciprocal relation between sentiments and emotions, for the cultivation of any set of emotions tends to foster a prevalent sentiment favorable to such emotions, whereas conversely and obviously, a sentiment is itself an invitation to the corresponding emotion.

Emotion and Volition.—Whatever view we entertain regarding the relation of feeling to volition—a matter discussed in the previous chapter—we must recognize that our emotional life sustains a most important relation to our conduct and character. A well-balanced, forceful character implies strong normal emotions, responding without exaggeration to the demand of human relations. The wholly unemotional person may meet the requirements of some occasional crises with great distinction, but in general he is likely to be a cold-blooded, unsympathetic individual, oblivious to many of the finer things in life. On the other hand some persons suggest by their behavior an active emotional volcano and from such we can hardly look for well-poised opinions or consistent and efficient conduct. We shall discuss more fully in a later chapter the relation of the will to instinct and emotion.

CHAPTER XIII

INSTINCT

Our analysis of emotion, leading us as it did into the region of instinct, carries us back to matters which we touched upon at the very beginning of our study. We must now look somewhat more closely into this part of our human equipment.

The Nature of Instinct.—Without making any pretense of precision in definition, it may be said at once that instincts, like reflex acts, rest upon the presence in the nervous system (both central and autonomic) of native pathways for the discharge of impulses into the muscles. Some of the instincts are perfect at birth. In all young mammals the instinct of sucking is of this character. Others appear and come to perfection at later stages of the animal's life. But whenever they appear, they involve innate, inherited forms of conduct and are in no sense learned or acquired like the voluntary forms of action. In general, they are to be differentiated from reflex acts in part by their complexity, the reflex involving generally a simple muscular response to a single stimulus, and in part by their being ordinarily conscious, whereas many reflexes are unconscious. After all, however, the differences are perhaps not so important as the similarities, and certain it is that the one passes over into the other through stages which are not separated by any sharp boundaries.

These instinctive and reflex activities serve to give the organism capacity to meet many of the more important situations to which it must adjust, and in certain of the lower animals they comprise substantially the sum total of its abilities. In the human being they form the foundation upon which is built all that individualistic adjustment represented by his personal experience. Not only does the human child begin his life career with a capital made up solely of these hereditary achievements; they remain throughout his life as dominating factors from which he derives the larger part of his more enduring motives. Our analysis of emotion will have naturally led the reader to anticipate that in discussing instinct we must repeat to some extent points which we have considered already. For we have insisted that our emotions are knit up in the most intimate way with our instincts.

As we pointed out in the preceding chapter, there are many possible classifications of emotions and instincts. For example, they have been grouped as social, or personal, as egoistic or altruistic, as defensive or aggressive. At present the commonest grouping is probably that which attempts to bring together instincts which are primary and relatively simple as over against those which are secondary, derived, and complex. All the divisions must be regarded as merely rough attempts to classify phenomena of which our knowledge is as yet too imperfect to warrant dogmatic assertions. Before entering upon this rough practical grouping, it may perhaps clarify the reader's view of the situation to point out certain peculiarities of human instincts as compared with those of the animals.

Comparison of Human and Animal Instinct.—It is commonly supposed that the higher animals possess

appreciably more instincts than does man. Professor James and others maintain, however, that a contrary statement is nearer the truth. Undoubtedly animals have more highly perfected instincts than any which we find in man. Certainly neither the child nor the adult displays any such remarkably elaborate instinct as that shown by the young spider in the construction of its first intricate web. On the other hand, it seems to be the fact that men have more *rudimentary impulses* of an essentially instinctive kind than any animal.

Neither in man nor in the animals, however, are instincts so blind nor so invariable in their operation as is sometimes supposed. Even reflex acts are some of them susceptible to appreciable alteration, and practically all exhibit marked variation from one individual to another. In the higher animals, many an instinct may be stamped out and disappear, either because opportunity for its development is lacking at the appropriate time, or because its first expression is followed by painful consequences. The disposition of the young chick to follow moving objects is one which passes away with some promptness if it be not cultivated. Commonly the maternal hen offers such an object and the chick's instinct is forthwith developed into a habit which may last indefinitely. Any of the less fundamental instincts may be temporarily, or even permanently, inhibited by painful experiences. The chick, again, has a strong tendency to peck at small objects. If those supplied be given a strongly disagreeable taste or be coated with some burning acid substance, the instinct may be gravely disarranged.

The plasticity of human instinct is much more familiar. Indeed, because of its variability there is little appreciation

of the really instinctive character of many forms of human conduct. The reactions to circumstances which cause embarrassment are essentially of the instinctive kind, and yet they may vary widely in different individuals and in the same individual at different times. The common expression of marked embarrassment is blushing. Some people, however, rarely or never blush, but are rendered dumb by embarrassing situations. Others express their distress by awkward movements of hands or face. Still others are overwhelmed with a rush of words, which in children and adolescents often tend to ill-mannered and rude expressions. One of these reactions may be made today, and another one tomorrow. This is simply to say that the instinct is of a very general and ill-organized type. As compared with the animals, probably all human instincts are decidedly more variable, and the reader can no doubt summon from his own observations abundant confirmation of this statement. Notoriously, some individuals flush when angry, others grow pale. Some persons become speechless when frightened, others tend to babble on like Tennyson's brook.

Human Instincts.—Let us return now to the attempt to make a rough list of the more important human instincts, and to suggest a working grouping. Professor James gives the following list: vocalization, imitation, emulation or rivalry, pugnacity, anger, resentment, sympathy, fear, acquisitiveness, constructiveness, play, curiosity, sociability and shyness, secretiveness, cleanliness, modesty, shame, love, jealousy, parental love, and hunting. MacDougall recognizes instincts to flight, repulsion, curiosity, pugnacity, self-abasement, self-assertion, and the parental instinct. From the latter he evolves sympathy and indirectly moral indig-

nation. He regards as minor instincts those leading to gregarious habits, to reproduction, and to construction. Watson, in his recent study of behavior, lists locomotion, the obtaining of food and shelter, rest, play, sleep, as the foundation of daily life. Instincts of sex, of defense and attack, migration, mimicry, and vocalization belong to less sharply marked groups.

Ribot distinguishes certain primitive tendencies, of which the more purely physiological have to do with the maintenance of the body. The others, of a more definitely psychological character, are related to distinctly social and racial situations. He speaks thus of the instinct of conservation under its defensive form as involving fear and all its modifications. Under its aggressive form this conservative instinct appears as anger, with its various derivatives. These are properly the primary group, upon which are built the more complex tendencies, finding their most definite expression in sympathy and the so-called tender emotions in general, such as pity, and the various forms of non-sexual personal affection. On the foundation represented by these three fundamental groups he would base all the other instinctive and emotional traits. Some, like the sex instincts, appear relatively late and are then complicated not only with the instincts which appear earlier, but also with the general fruits of experience. Still another grouping which Pillsbury has recently accepted recognizes (a) "those instincts which preserve the life and provide for the welfare of the individual; (b) those which provide for the continuance of the race and for the family, and (c) those which make for the welfare of the tribe or of the social unit." Evidently some of the instincts will overlap two or even three of the groups.

As has been suggested, the value of any of these proposed classifications is really dependent upon the particular interest or purpose which it is designed to meet. If one wishes to uncover the distinctly genetic phases of instinct, then a classification like that of Ribot or MacDougall, if it can be satisfactorily carried out, would be best. If one desires to throw into the foreground those considerations which pertain most distinctly to the evolution of society and its relation to the individual, then such a grouping as was mentioned last is likely to be most convenient. There is an added advantage in this type of classification in that it lends itself rather readily to use in connection with the modern evolutionary conceptions of mind.

Man has undoubtedly developed, like other living creatures, out of simpler antecedent forms. In the process of evolution his mental as well as his physical organization has been developed in response to influences which are partly physiological and partly social. Presumably in the life of the race, as in the life of the individual, the earliest exigencies are those which relate to food, rest, and protection from the assaults of climate and animal enemies. The instinctive equipment to meet these demands is represented in hunger, thirst, and the anger-fear reactions. Superposed upon the successful adjustment to demands of this character is the group of situations calling for effective social relations and leading speedily into the group centering first in the family and then in the tribe or social unit, whatever that may be. At one point or another in this series will be found the justification for each of the instincts which we have noted, the sum total representing a rude balance between those impulses which tend to foster on the one hand the purely personal interests of the individual, and on the

other those of the social group to which he belongs. As we shall see in a later chapter, the great function of voluntary action is to introduce a rational organization of these raw instinctive tendencies; but, even apart from rational control, on evolutionary grounds there must obviously always be an approximate balance between those instincts which tend to exploit the individual at the cost of society and those whose tendency is in the opposite direction. The social group is helpless without the individual, and the individual cannot really come to his own without the group.

Theories of the Origin of Instinct.—It will throw some light upon the general problem of instinct to survey for a moment certain of the more important theories regarding its origin. Of these we may mention three. At the present moment the one which we shall first describe probably enjoys the largest following.

(1) The *reflex* theory, which is perhaps most often in English connected with the name of Herbert Spencer, conceives instinct as built up out of the accidental conjunction of reflex acts in forms which are sufficiently useful so that the animals possessing them are at an advantage in the struggle for existence, and thus tend to survive when their less fortunate companions disappear. On the basis of this view, intelligence plays no necessary part in the original establishment of the instinct; indeed, the doctrine provides for the possibility that many of the lower animal forms may be very meagerly supplied with mental powers.

This view has to attribute the establishment of instincts essentially to accident, and it necessarily carries with it the further assumption that many of these accidents turn out unsuccessfully, so that neither they nor the animals

thus endowed survive. Inasmuch as accidental variations are well known to occur both in the structure and in the behavior of animal forms, this difficulty is perhaps not very grave. A more serious one concerns the fact that some instincts are extremely elaborate and consist of a series of relatively complicated acts, any one of which, taken alone, may be relatively useless.

If the preservative value of instincts is adopted to explain their existence, one is then apparently obliged to assume that the entire series of steps in a complex instinct sprang into existence at once (for any single step taken alone may be useless), and this seems highly improbable. In any event it strains one's credulity. The instincts in accordance with which wasps and bees construct their nests and lay up food supplies may reasonably be cited as instances of the type of difficulty mentioned.

(2) The next theory is that of *lapsed intelligence.* Among psychologists Wundt is probably the most conspicuous adherent of this view. It assumes that instincts arise out of acts originally intelligent and voluntary in character, that certain of these acts, being extremely useful and being oft repeated, get themselves established as firmly ingrained habits. These habits are then transmitted to offspring and so appear in the younger generations as innate.

Evidently this theory involves two fundamental assumptions without which it can hardly be made plausible at all. The one is that intelligence of the kind expressed in voluntary action is an attribute of the lowest animal forms. The other is that acquired habits may gradually become so well established that they are transmitted by heredity. Both these assumptions are vigorously challenged by scien-

tists of repute. The second in particular has been subjected to very severe arraignment by the great group of biologists who doubt or disbelieve that any characteristics acquired by an individual in his own lifetime are ever passed on by heredity to his offspring. The matter is still under active discussion and experiment at the hands of zoologists, and we shall have to await their final verdict. Meantime, the theory of lapsed intelligence probably enrolls a much smaller number of defenders than the reflex theory. It has one great advantage over the latter theory in that it is in a position to explain the slow building up of complex instincts, because it can make use of the selective influence of intelligence in picking out groups of useful coördinations.

(3) The theory of *organic selection* is represented among psychologists by Professor J. M. Baldwin. It maintains that consciousness is probably present and significant even in the very low organisms, and it may be assumed to be of value in just the same way that it is in human beings, i.e., by aiding in the adjustments which the organism makes in its attempt to accommodate its life to the exigencies of its surroundings. By the assistance of these rudimentary forms of intelligence, organisms may, in the view of this theory, be kept alive during the period when instincts are being slowly and more or less accidentally built up. Indeed, intelligence may conceivably exercise some influence in the selection or elimination of certain phases of the plastic developing instincts. The theory makes no demand, however, for assent to the doctrine of the transfer of acquired characteristics. It rather aligns itself in this matter with the reflex theory, urging that only spontaneous variations are ever preserved and transmitted by heredity. But it

obviously differs from the reflex theory in recognizing the possible presence of intelligence even in low forms of animal life, and in assigning such intelligence an active and indispensable part in keeping the species alive during the period when useful instincts are getting themselves established.

According to the last two of these theories intelligence is developed in parallel with the instincts. On the basis of the first theory, we must look for the appearance of intelligence at a relatively late point in animal evolution. Clearly if we turn to the life history of the human individual, we find from the beginning unmistakable evidences of reflex and instinctive acts, and although we do not find any developed capacities of voluntary control, we do find consciousness present, and we encounter at a very early stage the outcropping of definitely volitional processes. In the normal child the act of nursing will occur almost immediately after birth; but if the child for any reason *dislikes* the taste of the food supplied it, there may be also overt and violent refusal to accept it. There are many evidences, as was remarked earlier in the chapter, that instincts may be definitely modified and controlled by voluntary action. So far as concerns ourselves, then, we can only admit that while instincts and reflexes are dominant in the primary stages of our life history, intelligent control comes in at an early age to modify these inherited forms of behavior. That children ever inherit the acquired habits of their parents has never been proved, and is by most competent observers believed not to be the fact.

Instinct and Intelligence.—In the general process of evolution any particular generation necessarily carries over from ancestral conditions some instinctive forms of be-

havior which are either partly or entirely useless under extant circumstances. It is, indeed, probable that some of them are at times positively harmful. Clearly, such instincts are only likely wholly to disappear when they become so pernicious as to threaten the life of the species manifesting them. On the other hand, we know that disused organs tend to atrophy, and in the measure in which contemporary conditions fail to call out particular modes of instinctive behavior, there is always a chance that they may gradually disappear. Undoubtedly the broad general function of instincts is that already many times indicated, to-wit, the adaptation of the organism to the crucial features of its environment in advance of its individual experience. As soon as *knowledge* begins to arise about the effects of the objects in the environment upon the organism, intelligence can begin to act and voluntary control may come in to supplement or displace the unaided guidance of instinct. Many human instincts are still of the utmost value, not only because of the direct service which they render in advance of experience, but also because they furnish persistent and powerful motives to lines of conduct which are both individually and racially indispensable. The instinctive love of the mother for the child, the instinctive sympathy with many forms of suffering, the instinctive interest in acquisition, to mention only these traits is to name a group of instinctive tendencies whose removal would radically alter the whole texture of our social fabric.

CHAPTER XIV

ELEMENTS OF VOLUNTARY ACTION

We are now prepared to attempt what is essentially a synthesis of all the preceding analyses and descriptions of mental operations. The prime purpose of all sensations, acts of memory, imaginings, reasonings, and feelings is to enable us intelligently to control our conduct. This power of intelligent control is in common parlance generally called will. It is not the view of the present writer that the mind has any special faculty properly to be designated 'will.' Rather is this term to be understood as applicable to the entire mind when considered as an active directive force. To think is in a very true sense to will. To recall purposely is to will. To sign one's name intentionally is to will. In a way, then, we have already analyzed and described many phases of our volitional processes, but it is of distinct practical advantage to consider a special group of problems that still remain. These concern the means whereby we secure and maintain control over our muscular movements and thus become able at will to give expression to our thoughts, our wishes, and our decisions. There are also certain large general aspects of volition and character which merit more intimate analysis and description than they have hitherto received.

Stages of Motor Control.—Psychology is under no obligation to explain the *existence* of the muscular movements involved in voluntary action. From the beginning

of a baby's life these movements are occurring in a random, spontaneous or impulsive way. But the psychologist may fairly be held responsible for some description of the manner in which these uncontrolled movements become *organized,* as ultimately they do, into *effective coördinations,* like writing and sewing. In Chapter IV, to which the reader may well refer, we sketched the main outstanding features of this process of acquiring motor control, and that account we need not repeat, although we must enlarge upon certain phases of it.

An observer watching the progress of a baby's mastery of his muscles (as in learning to grasp an object which he sees), might well remark the following stages:

(1) A first period in which undirected impulsive movements of all the muscles occur in response to sensory stimuli, some of these being outside the body, some presumably inside.[1]

(2) An intermediate period in which a few controlled movements of the larger muscles slowly emerge. The control is very imperfect and many useless movements are always included.

(3) A final period in which skill in making the essential movements is achieved and the superfluous movements fall away.

(4) New coördinations may be taken on at any time, so that the three stages inevitably overlap, but any given act

[1] Some of the early movements are of course instinctive and represent pre-formed pathways through the nervous system The movements here referred to are mainly of the non-instinctive type. The pathways are opened up by the pressure of the stimuli coming in over the sense organs and are not, like the reflex paths, fixed and substantially uniform

passes through substantially these phases on its way to complete control.

Mental Factors Involved in Gaining Control.—Such an account as this evidently omits all reference to the mental processes which accompany such a course of development. Unfortunately psychologists are far from unanimous as to the exact nature of these psychic events. All are agreed that consciousness is energetically employed during the process of acquiring control, and that it tends to subside and busy itself elsewhere, as the coördination is gradually mastered. All are also agreed that sensations and ideas are employed in gaining motor skill, but the question as to just how they are used is a source of radical disagreement. Under these circumstances it will perhaps be most helpful to the reader if we sketch briefly one widely held view and indicate as we proceed some of the objections to it.

Let it be understood at the outset that the main points we have to deal with are (1) the nature of the mental *cue* by which a particular movement is called forth when desired, (2) how this cue originally got its power to serve as a motor control, with special regard to any differences which characterize (a) the period when a new movement is *being learned* and (b) the period *after* it has become reasonably automatic, and (3) what forms of mental control are employed to supervise *series* of movements such, for instance, as are used in piano playing.

Let it also be understood that we have no obligation to explain the fact that sensory and ideational states in general lead regularly to motor consequences. This follows from the nature of the sensory-motor circuit, which has been constantly emphasized. What we do have to explain

is the fact that a particular sensation or idea is followed by a particular movement, rather than some other. It may also be remarked at once that normally the only reason any sensation or idea fails to elicit a movement is that there exists some blockage in the neurones or that it comes into competition with some stronger idea or sensation and is overcome.

Owing to the impossibility of ascertaining just what goes on in the child's mind while he is learning to use his muscles, we are obliged to fall back upon a study of the behavior of adults when acquiring new motor coördinations. Obviously the two conditions present many important differences, but we must make the best of the situation.

Part Played by Sensations and Ideas of Movement.—Every movement of the voluntary muscles, however caused, produces kinaesthetic sensations and is apt to produce other sensations too. For example, if the arm is raised, we *feel* the movement and are likely also to *see* it. Now one view about the origin of voluntary action maintains that we are so organized that by *calling into mind the images of the kinaesthetic sensations aroused by any spontaneous or impulsive movement, we can again elicit the movement itself*. The development of voluntary control waits, then, upon the accidental occurrence of movements which catch attention, whereupon, by recalling the memory of the kinaesthetic sensations aroused, the movements may be repeated. Movements presumably catch attention most easily when they produce changes in some object already being attended to. A child looking at a red ball is fairly sure to notice the movement by which his hand comes in contact with it. Thus little by little the various muscular coördinations will be mastered.

This view maintains further, that as control grows, there is a speedy displacement of kinaesthetic images and sensations (called 'resident' by James, because they arise in the part moved) in favor of images and sensations (called 'remote') reporting the *objective results* of the act, rather than the mere fact of movement. The auditory word images of a verse we wish to write may thus serve as the only cue to guide the hand, the kinaesthetic imagery being entirely absent.

Whether this general theory squares with the facts the reader must try to determine for himself.[1]

Criticism has been principally directed at two points. It is said (a) that as every kinaesthetic sensation is caused by, and occurs *after*, a muscular movement, it is irrational and contrary to the general neural principle of habit to suppose that the sensation, or its image, can again bring about the same movement. If effective at all, it should call out some *succeeding* movement and not that which originally caused its appearance.

It is further asserted (b) that kinaesthetic elements, if employed at all, are merely supplementary to other kinds of sensations and ideas, and that they probably enjoy but rarely, if ever, any such primacy as is imputed to them by the theory we have been considering. Any mental cue,

[1] Shut the eyes and write the word 'echo' backward. Then try a long word like 'incomprehensibility.' See what sensory and imaginal material you use to initiate and control the movements. Try similarly some relatively novel movement, something you have not done before. Men can easily experiment on knitting or crocheting, women can try some unfamiliar musical instrument. If possible, detect what mental cues you employ to accomplish the necessary movements. Be sure to make some experiments with the eyes closed, to bring out the importance of visual control.

it is alleged, may be used to elicit a movement, provided only that by some combination of circumstances it has become associated with the latter as its antecedent. It is generally added by defenders of this view that 'imageless thoughts' often serve this function.

Tentative Formulation of Principles of Muscular Control.—Without being dogmatic we may formulate our views on certain general aspects of the subject as follows: To will an act is to foresee it and actively wish its occurrence. To foresee a movement implies having some representative of it in the mind. We cannot in any literal sense anticipate a muscular movement, or have any precise idea of it, until we know what it feels like, and this we cannot learn until it has occurred in some accidental way. The original spontaneous, impulsive movements afford just this necessary information, and the *memories of the movements and their results* afford the indispensable mental *representatives* wherewith to think of them and thus initiate the process of wishing and willing their recurrence.

Where interest is centered in the muscular movement for its own sake, as in some gymnastic feats, we probably use kinaesthetic sensations and ideas as the chief medium of control. On the other hand when the interest is in the objective result of the act, as in most of the occupations of daily life, we doubtless make predominant use of other more indirect forms of control. Whether children always begin their processes of motor learning with the kinaesthetic control, we cannot say. It can hardly fail to play an important part. But in the adult there are abundant instances where it apparently figures in only a very minor way. Certainly as expertness is gained, in any act, the controls become more and more remote. Any idea may lead

through an associative nexus to a given movement. One may open a window in order to look down on the street, or in order to air out the room. Two quite different ideas thus lead to the same act. Moreover, one and the same idea may obviously lead to very different reactions as when, desiring to find a coin, one first explores a pocket and then a desk drawer.

The author thinks the evidence quite clear that in some cases the kinaesthetic image of a movement actually serves to reinstate the movement,[1] and this may be the original tendency of all such mental factors. On the other hand it is equally clear that in coördinated series of movements, like skating, the kinaesthetic *sensations* serve as the cues for movements quite different from those which called them forth. Kinaesthetic *images* may well operate at times in the same fashion. But other forms of sensations and ideas are just as potent in motor control.

Reverting to the three points mentioned at the beginning of this discussion, we may summarize our position as follows:

(1) Any sensation or idea which has become associated with a movement as its antecedent may serve as the mental cue for its production.

(2) The cues first used are the *memories* of the accidental spontaneous movements and their results. Probably kinaesthetic cues are more largely employed in the early stages of motor learning, other forms speedily sharing this duty with them and after a time tending wholly to displace them. Ideas originally altogether disconnected with move-

[1] For an interesting hypothesis to explain the neural basis of this fact, see James' *Principles of Psychology*, Vol. II, Chapter XXVI.

ments may thus come ultimately to serve as cues for their production.

(3) A series of movements once initiated may go on with relatively little supervision, but in many cases there must be constant sensory direction, or the activity will go adrift. Writing affords an excellent illustration. The control may be, and generally is, carried on in the margin of the field of attention, only now and then becoming focal, when some difficulty arises which requires new adjustment—e.g., when the pen point catches and makes a blot. The sight of the word or the pen, the kinaesthetic sensations from the hand, or the sound of the pen on the paper, may any or all serve as the controls.

Objective Studies of Motor Learning.—As a result of many experimental studies of the process of habit formation in adults, an interesting group of facts has been brought to light.

If we arrange to measure, hour by hour or day by day, the rate of progress made in the mastery of a new accomplishment, we find, contrary to a common impression, that even when our effort is substantially constant and when ostensibly the difficulty of the task is also approximately uniform, we do not progress at a constant rate. Sometimes we go very much more rapidly than at others, and now and then there occur considerable periods during which we seem either to make no advance or actually to go backward. The accompanying figure 51 represents in graphic form the progress made by a person learning to send and receive telegraphic messages. Similar curves are available for many other types of accomplishment. It will be seen at once that the curve, instead of representing a straight upward-pointing line making an angle of forty-five degrees

with the base line, is extremely irregular, sometimes shooting up rapidly, then falling back again, and at two or three points presenting roughly a level region. Such a region is spoken of as a plateau. These are zones during which no advance was being made, as measured by objective achievement. The learner was performing no more rapidly at the end of the period than at the beginning.

It would be a great mistake to suppose that no growth

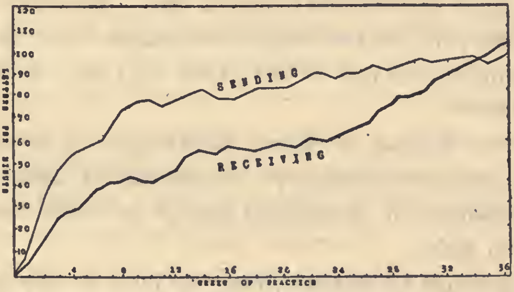


FIG. 51.—The lower horizontal line represents the number of weeks during which training was in progress. The vertical line the number of words which could be sent and received per unit of time. (Modified from Bryan and Harter.)

in skill is going on during these days. Some experimenters have, to be sure, called in question the necessity for such plateaus. But whether or not, under occasional ideal conditions they may be minimized, there seems to be no reasonable question that they reflect a genuine part of all familiar learning processes, especially such as definitely involve the attainment of motor dexterity. Apparently there comes a point at which the nervous system has assimilated as many new pathways as it is for the moment capable of receiving, and before profitable advance can be made in the using of such paths, there must be an appre-

ciable time for the sinking in and crystallizing of the new connections. After these have become firmly established, a new set may then be built upon these foundations.

Distribution of Effort in Learning.—An interesting corollary of these observations has to do with the distribution of effort and time in any process of learning, but particularly in such as we are here considering, in which motor coordinations are being established. Various opinions have been entertained regarding such matters as the length and frequency of practice periods most desirable for persons learning to play a musical instrument. There is a deep-seated prejudice among many music teachers that the only limitation to the advantageous length of a practice period is set by fatigue. The problem, conceived in a large way, is still in its infancy, but evidence is rapidly accumulating which strongly suggests that very much briefer periods of practice than have been customary are for many purposes advantageous. At the present moment no one really knows in any precise manner how many sets of tennis may best be played each day in order to secure a maximal proficiency most quickly. The judgment of experts, however, is rapidly growing in a direction which would confirm much recent psychological experimentation to the effect that a dozen men blunder by practicing too long and too often for one who blunders in the opposite direction. When it comes to a question of increasing mere muscular power, a different course may be wise, as will be indicated in a later chapter.

We have already had something to say about this matter in connection with memory. In general, it may be laid down as reasonably certain that while "line upon line and precept upon precept" is morally wholesome doctrine, it

must not be understood as meaning that judged by objective achievement each hour of effort expended will show an equal amount of tangible outcome. There are sure to be flat regions in the learning curve under almost all familiar conditions; but these regions are themselves the preconditions of subsequent rapid advance.

CHAPTER XV

WILL, INSTINCT, AND CHARACTER

Early in this book it was urged that we find acquired voluntary acts coming in to help out the short-comings of our hereditary instinctive equipment. The instinctive acts appear earlier and thus seem more primitive, and the voluntary acts are apparently built upon them. There is another phase of the relationship, however, which deserves mention.

Volition, Attention, and Instinct.—Volition in its developed forms involves choice among possible alternatives. These choices cannot be made effective until we have control of the muscles, but the necessity for making them would not arise were there not competition among our impulses and instincts. Attention is simultaneously appealed to by two or more stimuli, by two or more instincts, and in the nature of the case one or other must give way, unless conduct is to be paralyzed. Choice, decision, will, in the fullest sense of the word, seems to arise out of such circumstances, and those impulses and ideas which succeed in gaining our persistent attention are forthwith translated into action. Willing is therefore in the last analysis a psychological process of attending. When only one competitor can hold attention firmly, choice has occurred and the movements expressive of the decision will take place at the proper moment, in accordance with the procedure sketched in the previous chapter. Volition thus establishes organi-

zation among instincts, as well as among our random spontaneous movements.

If volition serves to organize instinct, instinct no less serves to furnish the most imperious motives to volition. Indeed, it is not too much to say that all the great persistent types of human purpose have their roots in instinct, and that the evolution of character in man is essentially a process of symmetrical development of his instinctive nature. Where some one instinct or group of instincts succeeds in dominating all the others, the result is a one-sided, and it may be a vicious, character. Or, looking at the situation from the other side, the absence of a proper development of certain instinctive traits may produce a weak and flabby character. At all events, it is desirable that we should consider for a few moments certain of these relations of instinct to volition.

Persistent Instinctive Influences.—As was pointed out in Chapter XIII, one of the earliest of these instincts to find expression is undoubtedly anger. It appears on the slightest provocation whenever appetites or desires are thwarted. Civilization has carried on a long and relentless struggle to try and keep the expressions of it within reasonable bounds, and religion and ethics alike have condemned its manifestations except in a qualified way in connection with issues involving the welfare of the social group. Nevertheless, there are probably few human emotions, few instincts which are more frequently stimulated and which in the gross play a larger part in determining human conduct. Many individuals will instantly resent the implication and deny the truth of this assertion. But if one remembers that irritation, exasperation, annoyance are all names for rudimentary forms of anger, and will then take

the trouble to trace the similar rudiments in many other emotions, such as jealousy, envy and moral indignation, the plausibility of the assertion will be recognized.

Fear, again, is one of the earliest and most persistent of emotional and instinctive motives. Physical fear is, thanks to the conditions of civilized life, a far less frequent experience than it was a few centuries ago.[1] But if one takes into account all the anxieties that connect themselves with ill-health, with precarious social and economic prospects, and with the course of personal affections, to mention no other phases of the case, it will at once be seen that the shadow of fear still hovers over most human lives in a very genuine way.

Turning from these more egotistical instincts to those of a more generous and socialized type, we come upon the great group of so-called tender feelings, the human affections, love and sympathy and pity, each of which plays an important part in every normal human life, and in some cases an altogether predominant part. So much is this the case that in certain highly organized individuals fear, at least, may be almost wholly abolished except in that vicarious form, in which it survives as anxiety for the welfare of others.

These considerations, brief as they are, may perhaps suffice to suggest to the reader the essential truth of the statement that instincts play a dominant part in determining the motives of voluntary conduct, and in keeping alive the vividness of interest necessary to the pursuit of a distant and difficult end. One other aspect of the case ought, however, to be brought more definitely into the foreground.

[1] The German method of conducting war has made the truth of this sentence very doubtful.

Transitory Instincts.—The instances which we have chosen as illustrative of the general truth under discussion involve emotions which characterize somewhat indifferently all periods of life. Certain there are which are more definitely periodic in character, belonging to particular stages of life or to particular forms of human experience. The adolescent period is generally characterized by a much more vivid interest of the sexes in one another than is met with at an earlier age, and of a character in some particulars quite unique as compared with that which has gone before. This type of interest, once developed, may extend indefinitely throughout later life, but it is apt to be most acute in its earlier stages and clearly takes its rise from the radical changes in the bodily organization which occur at that time. As compared with either anger or fear, this sex instinct is evidently more definitely limited to particular periods and to particular situations in life.

Of a similar episodal character is the love of the mother for her child, an instinct which obviously can have no full development in the earlier years of life and which may with childless women pass largely without expression. Despite the somewhat incidental character of this impulse, there is none in the whole range of the human instinctive equipment capable of more complete domination of the life of the possessor. These two instances may serve to represent a group of instincts which are in some particulars transitory, and, as compared with many others, of a distinctly more periodic character.

Intellectual and Aesthetic Impulses.—Although undoubtedly rarer as dominantly controlling influences in life, but nevertheless involving a genuine instinctive basis, should be mentioned those types of impulse which lead to

the pursuit of definitely intellectual ends. Thus certain individuals are said to have strong scientific interests, strong scholarly interests, and the like. These spring undoubtedly out of curiosity, or what may be called the hunting instinct in its intellectual form, the play instinct, and the instinct of construction. Probably no great scientist ever lived who did not feel an overweening inquisitiveness about the field in which he worked, who did not have something of the thrill of the hunter close upon his quarry, who did not find the pursuit of his science presenting all the thrill and stimulation of a game, with something of the competitive and combative instinct called out by the opposition of rival scientists,—who did not, in other words, carry on his work, however purely cold and intellectual it appears to the outsider, with much of the fervor and heat of the primitive animal impulse.

Similarly the artist responds in his professional work to a group of motives which are even more frankly of the instinctive kind. We have not listed in the catalogue of instincts any reference to the sense of beauty, nor would it be possible to include in any single term all that is involved in the constructive artistic impulse. It involves the play instinct, it often involves something of imitation, it involves strongly the tendency to self-expression, it has in it much of constructiveness, and it is saturated with appreciation of beauty, whether of nature, of one's own artistic production or of that of others. But however poor and inadequate our terminology, there can be no question that with many individuals the impulse for artistic construction predominates over most other motives, and that it is in a perfectly real sense native. No doubt all of us have vestiges of these more intellectualistic and artistic

impulses, but viewing mankind in the large, such motives take on power to control and determine the careers of only a few individuals.

Well Developed Character Depends on Balance Among Instincts.—What we had in mind in speaking of the development of volition as involving organization and balance among our instinctive propensities will perhaps now be more obvious than before. Certainly on the negative side it is clear that a life dominated by impulses of anger or of fear would create in the one case an anti-social and impossible character, and in the other a morbid and craven individuality. Over against such one-sidedness may be set the extreme sentimentalist whose entire life is a mere wallow of ill-directed sympathy. Such persons are the curse of many a deserving religious or ethical institution. Under the cloak of a fine and pure altruism they represent in fact a spineless and flabby tolerance for things and persons intrinsically intolerable. Not unknown is the individual so inflated with vanity and self-esteem as to render impossible all ordinary social relations. But little less distressing is the occasional person so afflicted with self-abasement, self-distrust, and timidity as again to render any normal participation in the business of society hopelessly impossible. Even so fine an instinct as that of parental pride and affection may be exploited to a point where it constitutes a neighborhood nuisance and an object of ridicule to all sane folk.

These instances will surely suffice to exhibit that which is involved in a reasonable balance of our instinctive equipment. To describe with precision wherein such balance consists would no doubt be difficult, if not impossible. But on the other hand there is no particular difficulty in dis-

cerning the lack of balance when it occurs in any marked degree, and it may obviously arise, as has been said, either out of the exaggeration of one or more of the instinctive groups, or from the suppression, partial or complete, of others. The history of civilization exhibits the process through which, little by little, the ordinary individual has come to develop such an equilibrium among his instincts as will permit a complex organization of the social structure. A moment's reflection will serve to show that the group of instincts most essential to the life of a primitive hunting people will differ decidedly from the group of those requisite to an agricultural form of life, and that both will make quite different demands upon instinctive traits from those needed in a highly organized industrial community. In each form of life the great motive powers which move the individual are found in these instinctive springs, but the particular balance best suited to one economic and cultural stage may well be quite different from that essential in another.

Volition and the Sources of Our Controlling Interests.—The view has been presented in this chapter that to will is, psychologically, to attend, and that in the process of attention we may expect to find the crucial features of volition. In connection with this doctrine it remains to add one further consideration, to wit, that the direction of attention is largely determined by interest. In a practical, common-sense way everyone recognizes that the mind tends to dwell most persistently upon topics of interest. This fact, when translated into terms of conduct, means that we tend to choose those lines of thought and action most compatible with these interests. When we attempt to catalog and classify the general range of human interests,

we find that the predominant and most widely distributed varieties center in our racial instincts, upon which we have just been commenting. Side by side with these general types which we share with all our fellows, e.g., interest in food, in warmth, in power, and in social prestige, is to be placed a group varying from individual to individual, but derived from a common source, i.e., such tastes, prejudices, and talents as spring from our personal family heritage in contrast with our human racial traits.

In every community there are certain to be individuals enjoying some peculiar capacity which by common repute has come down by inheritance in the family of the person concerned. This kind of thing is likely to escape attention unless the talents involved are of a somewhat unusual order. Nevertheless, the genuineness of the facts can hardly be called in question. Here is a child early manifesting marked interest in music and decided ability in that direction. Often in such cases it will be found that one or both parents enjoy the same marked characteristics, and frequently the quality can be traced back through a long ancestry. Around inherited predispositions of this kind is likely to grow up a set of interests which may be quite as imperious in their control over the conduct of the individual as are any of the more strictly racial tendencies. So far as the individual himself is concerned, interests of this character are quite as innate as any of the more purely instinctive kind, but it is clear that they represent a highly specialized group of traits which for some unknown reason have developed in a particular stock and are in no such degree common to men in general.

Even more striking than these cases of inherited family talent, with their accompanying intellectual and emotional

interests, are the rare but well authenticated instances of the occasional outcropping in a given person of remarkable tastes and abilities in no wise to be discovered in any of the immediate ancestors. This type of thing represents in an extreme form what is, no doubt, in lesser degree true of all men, to wit, an element of individual variation, carrying with it peculiar abilities and interests in no literal sense to be found in any other individual. The genius is conspicuously of this type. Perhaps the commonest example is represented by the appearance of marked intellectual interests and unusual intellectual talent in the child of wholly uneducated and commonplace parents.

It appears, then, that the controlling interests of any individual may derive from one or more of three different sources: (1) racial instincts, (2) family traits, and (3) individual variations, representing in nervous and mental organization what the botanists and zoologists call a 'sport,' that is to say, a variation which cannot at present be explained in any ordinary terms of inheritance. As the individual grows and develops, these centers of interest are necessarily brought into relation with one another, and some sort of organization is established. Certain interests, or groups of interests, gradually tend to attain mastery over the others. It must not be supposed that this statement implies the opposition of one group as a whole to another group. The controlling system may have in it elements from all three sources, and it is often extremely difficult to distinguish influences emanating from groups (2) and (3) respectively, Little by little, however, it comes to pass that there is established a certain system under which our daily life is passed.

Limitations Upon the Response to Interests.—Nor do

our interests merely as such enjoy a free fling in their own cultivation. The rugged and obstinate facts of the physical, social, and financial world create barriers beyond which we cannot pass, and within which we are obliged as best we may to seek fulfilment for our desires and ambitions. The direction, however, which the development of our conduct and character takes is essentially determined by this great nucleus of interests. Some we are born with, some, in a sense, we seem to acquire. But whatever the history of their origin, they are within us the eternal well-springs of our energy and activity.

An interesting instance of the way in which our instinctive traits are molded by social influences is exhibited in the facts of imitation. Although there are at least two, and perhaps more, forms of imitation, the one highly naïve, essentially reflex and characteristic of early childhood, the other more reflective and purposeful, many psychologists have been disposed to admit the essentially instinctive character of both. Certain it is that our mastery of most, if not all, of the forms of social intercourse known as etiquette rests upon imitative activities in which the individual is obligated by social pressure to follow the pattern set by usage. The occasional social anarchist who attempts to flout these usages speedily finds himself an outcast, or established in the unenviable category of the social freak. From earliest childhood on we are subjected to the incessant pressure of social customs, which on their higher levels appear as law, or as moral principles, whose rational justification is sooner or later urged upon us. In the thousand and one eccentricities of local or national usage we are thrown back for our acceptance of the established practices upon a purely unrational mandate to the effect that "all

well-bred people do it." To defy one of these mandates is to exclude one's self from the walks of polite society. Why should one lift his hat to a gentleman in Germany, but only to a lady in America? Why should one entertain a prejudice against the use of a steel knife for the purposes of a fork in polite circles in the United States, while no such prejudice is entertained in lower circles in this country, and neither in high nor low circles in certain parts of the Continent? Why should gentlemen in Europe wear their hair short and in Asia long? Why should ladies wear skirts in Europe and trousers in Manchuria? Why should the usage be exactly reversed for men? These questions have no rational answers, but to violate the dictates of the several usages involved is to reap a form of social whirlwind which few persons are curious or courageous enough to experiment with.

Development From Muscular to Intellectual and Moral Control.—Looking back over the materials of the last two chapters, it will be seen that the early stages of development of voluntary control are necessarily directed to the gaining of command over the muscles; that as soon as this motor control is established we proceed forthwith to make our muscles the tools for carrying out our aims, for securing our ends. The character of these purposes and aims is determined in the first instance by the urgencies of our instincts and appetites. In the early stages of life, those interests which are most immediately related to bodily comfort and sustenance are in the foreground. They never wholly lose their significance for us, but as maturity is gained they rapidly lapse into the background, giving way to other forms of interests connected more definitely with our social and moral relations and with the growth

of our general intellectual life. *Not the least important of the features of this later stage of our development is our growing control over the process of thought itself.* The little child is quite incapable of sustained reflection. The disciplined adult is able to give himself if necessary for hours at a time to undiverted thought upon his own future conduct. This gain in power is primarily a gain in ability to hold attention to a process of thought. When a decision is reached, the line of conduct selected is carried out by the muscles almost automatically.

CHAPTER XVI

SLEEP, DREAMS, HYPNOSIS, AND MULTIPLE PERSONALITY

Over against our waking experiences, with which our discussions have hitherto dealt, are properly to be mentioned certain facts about sleep which occupies the other part of our lives and which is characterized by a peculiar form of consciousness of its own, that we call the dream.

Main Facts About Sleep.—Despite the extended and ingenious experimental investigations of sleep, there is still among physiologists no complete agreement as to its causes. The dogmatic statements which are often made about it must, therefore, be understood as expressing the opinion of individuals rather than the final verdict of science. Certain general features of the phenomenon may be mentioned.

Although in sleep the central nervous system is clearly less excitable than during waking periods, it would be a mistake to think of it as in any sense completely inactive. Sensory stimulations which in waking conditions would produce sensations may, in sleep, be quite ineffective; but the presence of dreams and of certain of the reflexes, to say nothing of the activities of the autonomic system, whereby the vegetative processes of the organism are maintained, show clearly that neural excitation of some kind is in progress. During sleep the blood vessels of the brain are relaxed, and the pressure in the entire body is lowered. A common view is that sleep is to be regarded as an instinc-

tive reaction, which is favored by conditions of moderate fatigue, of quiet, of habit, and of expectancy, although no one of these alone may be able to induce it in a given instance. There seems to be no doubt that during sleep the waste of tissues which goes on during the waking period is repaired, and there is good evidence that the cell bodies of the neurones restore certain of their substances which are broken down during waking. Experiments have made it quite certain, too, that under normal conditions the depth of sleep, as measured by the power of an auditory stimulus to awaken the sleeper, increases for about three-quarters of an hour to an hour, then falls very rapidly until between the third and fourth hour, after which an extremely slight sound may cause awakening.

Dreams.—The diversity of opinion regarding the immediate causes of sleep is reflected in a similar divergence of opinion regarding the continuous presence of dreams during sleep. Undoubtedly the commoner view today is that absolutely dreamless sleep probably does not occur. Our frequent inability to recall dreams is attributed to the rapidity with which we forget them upon awakening.

There is little question that the stimulus to the beginning of a dream is often a sensory excitation, a sound, the pressure of the bed clothing, the chill of a draught of air, or the like. But once the dream is started, the course which it takes is apparently controlled by much the same associative principles as we have previously described in connection with memory and imagination, but under little or no control from any definite purpose or intention, such as commonly presides over our trains of waking thought.

Freud, the Austrian psychologist, has recently urged that all dreams represent the expression of suppressed wishes

which one dares not frankly confront during waking moments. He also believes that the particular ideas and images in which the dream is embodied are symbolic and often represent situations quite other than those immediately suggested by the images themselves. Freud believes that in this way many desires and wishes are cherished and given realization in the dream imagination, which could otherwise gain no hearing, because of their hostility to the ideals and prejudices of the waking mind. Thus one's moral convictions might altogether prevent the indulgence overtly in acts which in this more or less symbolic dream form are freely cultivated. The dream thus offers a field for the fruition of a great group of impulses and desires which the inhibitions of society and of moral training exclude from waking experience.

Fatigue.—Whatever the explanations of sleep and dreams, there can be no question that sleep is essential for the repair of the physical and mental exhaustion coming from work. Fatigue is a perfectly normal phenomenon, and may, indeed, be thought of as essential to many forms of growth. Certainly no one can secure hard and well disciplined muscles who does not use them to the point of fatigue. On the other hand, over-fatigue may be a very serious matter, and any type of experience which robs us of sleep for any considerable period of time is likely to be extremely disastrous. Experiments have made it fairly clear, as mentioned above, that the nerve cells undergo definite physical changes under excessive use, in which certain of the tissues contained within them are used up. Similarly it has been shown that the muscles under fatigue become clogged with waste material, and the blood is invaded by poisonous elements thrown into it by the action

of the body tissues. Under normal conditions the recuperation from fatigue is prompt and complete.

Conditions of Effective Work.—Evidently the highest efficiency implies such a combination of periods of work with periods of rest as shall enable the maximum accomplishment compatible with the maintenance of the organism in robust condition. One can 'spurt' for a considerable period of time under pressure, but such spurts are inevitably followed by disproportionately long periods of rest, if one is to regain one's original freshness. Most individuals organize their daily lives in too haphazard a manner to make this matter of work and rest of any great consequence. This is another way of saying that they waste a very large part of their time and energy. It is quite possible to ascertain with approximate correctness the length of the intervals during which one can work intently to advantage, and also the length of the interval of rest which may best follow upon such occupation.

For the average person of sedentary life, engaged upon intellectual tasks, an hour or two of really concentrated labor is likely to be as much as can be profitably indulged without respite, if one is to work successfully day after day. It is often said that the only rest which is then needed is a change to some other form of work. But the best experimental evidence does not confirm this. The resting interval should be occupied in a way to furnish a minimum of mental exercise and this of a diverting and recreative character. Mild physical exercise is good, but severe physical activity is itself tiring, producing an unfavorable effect upon any immediately succeeding mental operation. The best studies of fatigue indicate quite strongly that mental and physical fatigue are in the last

analysis one. The length of the interval of rest ought not to be so brief as to leave one still feeling dull and tired, and on the other hand it ought not to be so long as to oblige us to start at the beginning in 'getting up steam,' for it is a common observation that in undertaking any serious task there is a period of 'warming up.' It is obviously in the interest of efficiency to abbreviate this period as much as possible.

Pillsbury and other investigators have shown that individuals vary considerably as regards the time of the day when they work to best advantage. This does not mean that the ordinary individual is incapacitated for work altogether at any particular time. It does mean, however, that some persons can accomplish their best work in the morning, some in the afternoon, and some in the evening. It goes without saying that these peculiarities are to some extent subject to training, and that what appears to be a preference for one of these periods may in point of fact be only a result of a habit, which can by the expenditure of effort be changed.

The subject of sleep and dreams leads naturally to a few comments upon certain other variations of normal consciousness which are of interest.

Production of Hypnosis.—Hypnosis, which, as the word suggests, is a state in many particulars closely resembling sleep, has attracted wide scientific attention in recent years. Skilful operators can transfer a person in normal sleep to a condition of hypnosis. But ordinarily the hypnotic condition is induced by special processes which result in throwing the waking patient into a condition at first resembling light slumber.

There are many methods for producing hypnosis. Some

are successful with given individuals, but fail with others. Practically all normal persons who desire to be hypnotized can by one method or another, if the attempt is repeated often enough, be at least slightly affected, and a very considerable number can be drawn into the deeper forms of hypnosis. Whatever the detail of the procedure, the methods all have in common the fixing of attention upon some monotonous, and if possible, soothing stimulus. A common device is to 'talk sleep' while stroking gently the brows of the patient, occasionally making gentle passes with the hands down over the arms and trunk. Many of the earlier operators were wont to employ fixation of the eyes upon some bright object held a little above the bridge of the nose, so that to look at it would involve a fairly pronounced strain of the eye muscles. Other operators have at times used the ticking of a metronome, or the flashing of light from rotating mirrors. Others have pressed on the palm of the hand. Once a subject has become accustomed to following the directions of the operator, who assures him from time to time that he is falling asleep, almost any signal will serve to bring on the hypnotic condition.

As in normal sleep, the subject may simply become slightly drowsy and then arouse again, or he may sink into a deeper sleep lasting for an indefinite period. From this sleep he may ordinarily be aroused by the command of the operator, or if left alone, he will generally wake up after a little while of his own initiative.

Suggestion in Hypnosis.—Perhaps the most striking feature of the hypnotic condition is the patient's remarkable susceptibility to suggestions given by the operator. In waking life, we are all subject in a certain degree to the effects of suggestion. If we are told that a speck high up

in the sky is an aëroplane and that by looking sharply we can detect the wings of the machine, we are very likely to see what we are told, even though the object be a bird and not a flying machine. In our discussion of sense perception we had occasion to remark that the larger part of the things which we see and hear are perceived in accordance with the *suggestions* given to us by the physical objects, rather than in any literal sense as they really are. But in hypnosis this normal suggestibility is much exaggerated, and is ordinarily confined to the words and acts of the operator. Indeed, as we have intimated, the sleep is brought on by a process which is essentially one of suggestion.

People vary very much in the extent to which they are affected by hypnotic suggestion, and they tend also to become increasingly susceptible under repeated hypnotizing. In describing the more conspicuous phenomena, it may be understood then that we are describing conditions which would not necessarily present themselves in any one individual in the earlier hypnotic experiences.

Symptoms in Hypnosis.—We may roughly group the characteristic phenomena under the following headings: (1) sensorial, (a) anaesthesia and analgesia; (b) hyperaesthesia; (c) hallucination; (2) amnesia, i.e., loss of memory; (3) motor, (a) paralyses; (b) catalepsies; (4) post-hypnotic effects.

(1) (a) It is ordinarily easy to produce by suggestion insensitiveness to contact with the skin, even though the stimulation be painful. The back of the hand may thus be rendered insensitive, so that it will not be moved even if cut, pricked, or burned. (1) (b) Similarly it is not difficult to produce hypersensitivity of sense perception, as may be illustrated either in visual or cutaneous stimulation.

If a coin be pressed upon the skin of the forehead, the normal individual can generally perceive the object as circular in shape, but this is usually all. The hypnotized person may be quite able to give an approximately correct report of the design on the coin. Again, if a pack of fifty plain cards, like calling cards, be shown to the hypnotized individual, and he be asked to note one in particular, he can, after the cards are shuffled, pick out the original with a precision far excelling that of the ordinary individual. To make this test it is of course essential to have the critical card marked on the reverse side in some way to permit the experimenter to identify it.

(1) (c) The evidence about the production of hallucinations is somewhat ambiguous, but it is generally accepted that in the deeper hypnoses at least they may be encountered. If the subject be presented with a blank piece of paper upon which he is assured there appears a sketch of a tree, he may agree, upon being asked, that he actually sees the tree; and if a pencil be put in his hand, he will ordinarily trace the outline of the fictitious suggested object. Despite a good many forms of control, it is difficult to be sure whether in every such case the subject really sees what he alleges, or whether he simply gives verbal assent to the suggestion and adjusts his conduct to fit the circumstances as the operator describes them.

(2) There is great variation regarding the degree to which upon being aroused from the hypnotic sleep different subjects recall what has gone on, but after deep hypnosis, there is usually almost complete forgetfulness of what has occurred. The memory of the period is, however, obviously preserved, because in a subsequent hypnosis every detail of the experience may be recalled. Moreover, if, during the

sleep, it be suggested that the subject will recall a particular circumstance upon awakening, it is practically certain to be remembered.

(3)(a) One of the most easily produced results and one which is often used as a definite symptom of the presence of genuine hypnosis is the inability to move the voluntary muscles, especially those of the eyelids. At a certain point in the oncoming of the hypnotic sleep the operator says: "Now you cannot open your eyes"; and sure enough, struggle as he may, the patient finds that he cannot lift his lids. (3)(b) In the same fashion the muscles, if put into a given position, the suggestion being added that they cannot be moved, will remain for an astounding length of time rigid and tense. Under these conditions they will sustain a strain quite beyond their normal capacity. The stock exhibition of this phase of hypnotic phenomena consists in stretching the patient out with head and heels resting on two chairs and the rest of the body unsupported. This achievement is quite beyond the muscular powers of most individuals, but under hypnosis considerable weight may be added to the subject's own body without destroying the muscular resistance.

(4) Amazing as are many of these peculiarities of hypnosis, the ability to carry over the effects of suggestion into the subsequent waking life of the subject is even more striking. The therapeutic value of hypnotism has generally been regarded as depending largely on this feature. A person suffering from morbid dreads or anxieties, when assured in hypnotic sleep that on awakening these mental disturbers will not be encountered, is often freed from the distress and suffering for a considerable length of time. The most scientific treatment of nervous and mental trou-

bles, however, is not today made dependent upon this type of direct suggestion. We cannot enter here into any detailed explanation of the reasons for this change of procedure. Suffice it to say that more lasting results are gotten in other ways. The point here is that suggestions given during hypnosis are often carried out after awakening in the most remarkable way, and often without any consciousness on the part of the patient that he is executing commands which have been previously given to him.

For experimental purposes a common type of demonstration would be illustrated by an operator's instructing a patient to return at a certain hour three weeks later, bringing with him some quite improbable object, like a basket of fish. Odd as it may seem, in nine cases out of ten the patient and the fish will be forthcoming at the time and place set. Not only so, but the victim of the experiment is fairly certain to turn up provided with an ingenious account of why he has come. Moreover, the whole performance may be carried out without suspicion on the part of the subject that he is serving the cause of an experimental demonstration.

The psychological explanation of these post-hypnotic suggestions is not at all clear, although in many cases what seems to happen is that the suggested idea begins to grow and develop and justify itself from the time it is first implanted until it comes to fruition. In general the explanation of hypnotic behavior is far from certain, and all that can be said briefly is perhaps that most, if not all, of the phenomena encountered appear to hinge upon the severing of the marginal portions of consciousness from the focus, and this focus appears to be determined by the operator. The practical effect of the situation is to

eliminate the ordinary inhibitive influences of opposing ideas, which under normal conditions would enter to modify and control the subject's behavior. Such restraining ideas being absent, the subject carries out by his actions the thoughts which are thus left in possession of the field.[1]

Trance Mediumship.—This condition of hypnosis presents many similarities to the so-called trances of the spiritualistic mediums. Although it seems necessary to admit that a considerable proportion of the professional mediums are fakes and charlatans, there is no question at all that certain individuals, perhaps victims of hysteria, pass from time to time into a condition where they become more or less oblivious to ordinary sense impressions and either verbally or by writing express the thoughts and sentiments of some 'spirit control.' Under these conditions they purport to convey information and advice regarding matters of which they are themselves entirely ignorant. Many of them have laid claim to supernatural physical powers, such as the ability without physical contact to lift a table and hold it suspended in the air. In practically every case where these pretended supernatural capacities have been carefully studied, they have been found dependent upon clever tricks of one kind or another, which have been successfully repeated by stage jugglers and magicians who lay no claim to anything but cleverness and prestidigitation. Meantime, the trance condition is undoubtedly real in a certain number of these cases; but it does not follow that the alleged clairvoyant and telepathic powers which these persons often claim have any basis in fact. It is

[1] No inexperienced person should attempt to hypnotize. Serious harm may be done.

fair to say, however, that not a few men of high scientific standing, and perhaps foremost among them the late Professor William James, have been quite convinced that some of the knowledge possessed by the trance mediums cannot be explained on the basis of our ordinary methods of sense perception, nor by the communication of ideas from mind to mind through language or other physical signs. It is equally fair to say that the great mass of competent scientific opinion is quite of another kind, that it refuses to recognize any appreciable body of well-established evidence calling for belief in telepathic or spiritualistic communications, whether as between living people or between the living and the dead.

Multiple Personality.—Just as the phenomena of dreams, which are perfectly normal experiences of every human being, lead us out gradually into phenomena of an essentially abnormal kind, so certain conflicts within our characters suggest in a very rudimentary way the beginnings of abnormal divisions of personality. Few more interesting phenomena have been studied in modern psychology than the so-called 'multiple personalities.' Although in the last analysis the several varieties are probably all reducible to a common type and are all symptoms of hysteria, the division suggested by Alfred Binet is convenient for the few comments which we can make upon the matter. He distinguishes *successive* and *simultaneous* alterations of personality.

In the successive form, the patient may wake up some morning to find that he has entirely forgotten all his previous life, his name along with the rest. Whereas before he may have been a somewhat lethargic person of equable temperament, he is now extremely active and of

somewhat irascible bent. He starts in to build up a new life, oftentimes disappearing entirely from his old haunts. His memory processes go back only to the beginning of his attack, but from that point on they may be entirely accurate. Suddenly, some weeks or months later on, he reverts to his original character. The memories of the secondary state disappear wholly or almost wholly, and often he succeeds after a time in getting back to his old home. This type of alteration may occur again and again throughout a long lifetime, and it may be complicated by the introduction of two or three more similar personalities. In each state he may find himself more or less completely cut off from memory of the other alternating states.

In the case of the simultaneous multiplication of personalities, it is as though these successive states were in some fashion telescoped upon one another, so that in a certain sense they co-exist side by side. It is extremely difficult to frame any readily understood picture of how this kind of thing may go on, but the reader may with great delight to himself follow the dramatic history of one such case in Dr. Morton Prince's *Dissociation of a Personality.* In this case there is a constant struggle of the several personalities, whose characters differ from one another in the most radical way, to secure control over the speech and conduct of the afflicted person. Sometimes one comes out ahead, and sometimes the other. The memories of one are quite hidden from access to some, at least, of the others.

Subconscious Processes.—These cases of multiple personality of all varieties exhibit in the most striking way the extent to which subconscious processes may operate. They all tend to suggest that the divisions underlying these

disturbances are connected with the distinction between the focus and the margin of our awareness. If concentration becomes highly intense, there may be a severance of the central from the peripheral regions of our consciousness, and what goes on in the margin may then get itself split off as a type of subconscious activity. Obviously elements which are represented in the margin may in no true sense be really lost to the organism as a whole, but they may be quite completely excluded from access by the focal parts of the mind. In normal conditions this type of thing is represented when we become so absorbed in what we are reading that we do not notice the striking of the clock; and yet five or ten minutes later we may 'come to' and feel quite sure that although we did not notice it at the time, the bell was actually heard. In the same way if our attention is keenly preoccupied, we may do the most absurd things under the guidance, more or less subconscious, of our habitual activities. The stock instance of the man who goes upstairs in the early evening to put on evening dress preparatory to an invasion of society, only to find himself in bed as the result of carrying out the operations necessarily begun in the changing of his attire, is a perfectly good example of this type of thing. Who is there that has not become so preoccupied when on the way home that he has gone far past the proper turning point and been obliged to retrace his steps. These instances one and all tell the same story of the part played by the marginal elements in our awareness, which ordinarily prevent our cutting too completely adrift from our actual surroundings.

CHAPTER XVII

THE SELF

It has been necessary thus far to deal with the several elements of human behavior to some extent independently of one another, although certain of their interconnections have been pointed out. We have found the mind to be an adjustive activity making use of sensory and ideational materials in order to gain control over its environment. We have noted the part played by instinct and feeling and emotion in determining its fundamental attitudes toward this environment, and we have observed something of the way in which motor coördinations are built up out of the raw material of uncontrolled movements, until adequate habits are finally established fit to cope with the exigencies of life. We have remarked throughout all this process of growth, as one of its great practical results, the development of character, with its rational principles of conduct, its cherished ideals, its established modes of social behavior. Now it behooves us in conclusion to dwell for a little upon the personal *self*, whose experiences we have thus analyzed.

The Identity of the Self.—There is a deep-seated popular conviction, resting perhaps as much on tradition as on any intuitive or reasoned certainty, that the self continues in some way unchanged from moment to moment and from year to year. In any event, contributing to this conviction of the persistence of an identical self are many factors, and ranking high among them in importance is undoubtedly the fact of memory. I can recall today and again

tomorrow the events of last year, and the memories of them may appear very similar on both occasions, may elicit the same feelings and the same motor reactions, so that I come naturally and without much reflection to develop a sense of sameness in myself. My anticipations also play a part, for again and again there recur the same desires for the same ends as yet unattained. Another fact which doubtless contributes to the total result is my fairly constant, though dim and vague, awareness of my own organism. The importance of this consideration is suggested by the fact that any serious disturbances in the organic sensations, which report to us the bodily conditions, occasion great uneasiness and distress, and, if profound, may form the basis of malign mental disease. Not least striking among the more immediate forms of evidence is the fact that after sleep or any form of unconsciousness, the mind normally resumes its hold upon the interrupted stream of events, claims its own out of the past and goes on as though no interruption had occurred. More subtle is the contention that the very notion of consciousness, like the derivation of the word (con-scious-ness—knowledge over against something), involves a subject, a personal agent, a knower, presumably the same from instant to instant, who *knows* the particular idea present at the moment, *feels* the pleasure or pain and *wills* the action determined upon. What we have been describing in this book is on this showing simply the content of the mental states of such a knower. Finally, philosophical and religious speculations have furnished an impressive body of doctrine concerning the perdurable character of the soul, which tends distinctly to confirm this widespread conviction of a persistent identity in the self.

Objections to the Common Idea of Self Identity.—There are, however, certain facts which cannot be easily reconciled to this view. While it is true that we remember much of our former experience, it is also true that we forget much. If we are going to rest the unchanging identity of the self on its retention of its own past in memory, it must be frankly admitted that the identity is only partial, for many portions of one's experience fade out and cannot be revived. Desire and anticipation similarly change and develop, despite the existence of a core of such desires which may remain fairly constant. Obviously the self at forty years of age is better informed than the self of four, or even than that of fourteen. It has very different memories, different tastes, prejudices and abilities. Character at these different stages is apt to be widely different. Obviously, too, the physical body changes in very marked ways as the years go by, and to some extent the organic sensations by which it reports to the mind are likely also to change—slowly to be sure, but none the less certainly. Furthermore, the cases of dissociated multiple personality described in the previous chapter serve to show how flexible and plastic the self may be. All things considered, therefore, we must recognize that such identity as the self possesses is probably not altogether of the type assumed by common-sense and popular tradition. Two additional circumstances should, however, be noted.

Continuity of the Self.—There is (1) undoubtedly a *continuity* in the life of the self which is in one respect like that possessed by all living organisms. The oak tree is different in almost every particular from the acorn from which it grew, and yet we speak of it unhesitatingly as the same tree year after year. It has a continuous *life* and

this fact we recognize in our manner of speech about it, however widely its appearance may vary from season to season and from decade to decade. This same continuity of life man obviously enjoys, but beyond this is the fact that he *knows* and *feels* this continuity as the plants and many of the animals presumably do not. This continuity of experience does not for a moment preclude growth and change, as the more rigid and static conceptions of personal identity seem to do. It rather renders such alterations intelligible, as stages in the evolutionary adjustment of a living mind to the shifting winds of circumstance.

Unifying Tendency of the Self.—Again there is (2) a very genuine sense in which the self may be considered as an organized unity. Despite the fact that many of our experiences are lost from the mind through forgetfulness, despite the facts of dissociated personality and despite lapses in moral behavior, one of the great outstanding characteristics of normal mental phenomena is that they tend to cohere into connected personal groups with systematic principles of organization. Intelligent processes of adjustment would, indeed, be impossible were this not the case. While never at any one time then a *completely and perfectly unified affair,* the self possesses intrinsically unifying and organizing tendencies. As long as it continues to grow, it is always expanding its boundaries and organizing more thoroughly its possessions.

Thus far we have dealt only with certain general aspects of the problem of the self as this emerges from popular tradition. We must now inquire more precisely what is the actual content of the individual's idea of the self both in his own person and in others. This will lead us

to examine briefly the conditions under which the consciousness of self develops.

Social Origin of the Idea of Self.—It may be alleged with reasonable confidence that the consciousness of the self does not appear ready made, but that it is a result of a slow process of growth. There seem to be fairly good reasons for believing that one of the early distinctions remarked by the child is that between persons and things. Things are relatively stable and uniform in their modes of behavior. They are unmoved by the child's desires, by his gestures or his cries. Persons on the other hand, while in some ways more variable and unreliable, are vastly more responsive to the child's appeals, and they minister to his comfort and the satisfaction of his desires in a manner wholly unique. Moreover, as soon as sufficient motor control is obtained to permit this indulgence, persons afford much the best and most interesting patterns for imitation. Such imitation repeatedly brings agreeable and exhilarating results. Perhaps most important of the contributions made by persons to the emergence of the idea of the self is the gift of intelligent speech. And not least significant in the use of language is the fact that the child is referred to by a name and no other person or thing shares it. It is his by exclusive proprietorship. The personal pronouns are also taught him and gradually he begins to read into them correct and adequate meanings. On every side he is thus surrounded by influences which tend (1) to draw his attention to personality, as concretely embodied in other human beings, and which (2) strongly impel him to think and speak of himself as a person. There can accordingly be no question that the definite consciousness of self appears amid social relations

and in response to social incentives. It is from the first a distinctly social phenomenon.

Content of the Idea of the Self.—What particular content is at this point employed to fill out the idea of self it seems very hazardous to allege. Later on in life when introspective evidence is more available, we find quite a variety of factors reported. To think of the self is apparently for some persons simply to get a visual image of the face or figure as it appears in the mirror. Again it may involve the awareness of the organic and kinaesthetic sensations which indicate bodily attitude and condition. Not infrequently it is a *concept* built upon one's surmise of the esteem in which one is held by others. In this case it is likely to be closely identified with descriptive verbal ideas, e.g., 'good fellow,' 'able man,' 'cad,' 'fool,' accompanied by emotional attitudes of depression or elation as the case may be.

It may occur to the reader that there are many conditions designated in terms of 'self' experience to which these descriptions are quite inapplicable. Self-conceit, self-confidence, self-distrust, self-sacrifice, self-consciousness—these and many others will suggest themselves. On these instances two comments are to be made. In the first place several of the terms apply ordinarily to general attributes of character, rather than to specific mental experiences. Such are self-confidence, self-conceit, self-sacrifice. In the second place so far as one *actually feels* self-confident, or self-conscious, one's thoughts are not necessarily directed to the idea of the self at all. One who feels self-confident may be contemplating an act to be performed and his self-confidence may consist simply in the absence of anxiety and worry. The self-conscious person is likely

to be afflicted with an inconveniently vivid awareness of his own organic discomfort, his trembling knees, blushing cheeks and awkward gestures, but there may be in his thought only the most remote reference to the idea of the self.

It appears therefore that whatever may prove in a given individual to be the content of his 'self' experiences, the mind is only incidentally and occasionally engaged with the idea of self and only now and then attentive to the 'I' complex of organic or other sensations. A constant attention to this complex is one of the symptoms of a neurotic and morbid temperament. The fact that one's thoughts and feelings all belong to the continuous and more or less unified experience of a self, must accordingly not be confused with the unacceptable doctrine that one is always conscious of the self as such.

There is one differentiation of the idea of the self which is based upon actual differences in behavior to which reference should be made. In the complexities of civilized life a man may be called upon to build up very different habits of adjustment to different surroundings, and so it may come about that the deportment of the man as observed by outsiders may well suggest very divergent types of character. The manager in the office at the mill may be gruff, abrupt, severe, even harsh. The same man at home may be considerate, gentle and affectionate. His companions at the club may encounter still a different person and these variations of conduct may be multiplied quite indefinitely. For each of these 'selves' the man himself is likely to entertain a somewhat distinct 'self' idea, although the chances are that in his own appreciation the several selves differ from one another far less than appears

to his intimate acquaintances to be the case. Self ideas of this type are very apt to be colored by regard for one's possessions, one's social position and attainments, and this is perhaps especially true of the estimates one forms of the selves of other men.

Moral and Religious Influences upon the Self.—Moral and religious ideas exhibit peculiarly significant relations to the self. The ideas of right and wrong get their specific content in the course of the individual's moral development and through his reactions to the rewards and punishments meted out to him by society. In morals as in law the individual finds himself treated as a responsible agent and here again therefore his personality, his selfhood, is projected into the foreground of his reflective attention.

Religious experience in this respect goes even further than the usual moral experience in that it compels the individual to think of himself as in relation with a Supreme Being whose character is such as his own may become by penitence and struggle. There is, in other words, peculiarly compelling emphasis upon the idea of companionship with a perfect self.

Types of Personality.—"One of the most interesting tasks which the psychology of the future will have to face is that of delineating the various typical forms in which personality reveals itself. But at present such descriptions cannot be more than rude impressions of individual observers. In history and literature a few of these great types have been recognized. We meet here the mystics, the poets and dreamers, the seers, some of them fiery, impulsive personalities, others gentle ascetic souls, but all of them, with a gift for vision as against the prosaic

processes of tedious reasoning, and with varying powers of adequate expression for their insight. Then there are the scientists and scholars with a religious conviction of the worth of plodding care and the paramount value of facts. Sometimes this trait is married to fervor and emotional tension, sometimes it is embodied in cold calculating temperament. Then we find the great leaders of men, the military and industrial geniuses who compel by sheer force of personality, by aggressive capacity of hand or brain; the religious leaders who succeed in awakening the spiritual devotion and confidence of men. The average man no doubt has in him something of the various elements represented by all these great types, but they exercise a less imperious sway over him and are conjoined with capacities too weak and commonplace to stand out boldly from the mass of humanity.''

Meanwhile we are only just learning how important it is for the ultimate welfare of society that each man shall be placed where his qualities fit him to serve best, and our psychologists are doing more than their share in the perfecting of methods for determining the special combination of mental abilities possessed by each individual. When these methods are thoroughly assimilated into our educational procedure, we may look for a vastly higher order of human efficiency and we may hope for a much higher *average* of human happiness and contentment. It is particularly important that society be in a position to identify and exploit the useful individual variations which are now often hopelessly submerged and lost in the rough-and-tumble methods by which men get located in special jobs. Once settled down, the misfit may go through life, a nuisance to himself and a dead loss to society.

Summary.—The reader is now doubtless prepared to appreciate from how many different points of view the self may be approached and how numerous are the problems it presents. In this chapter we have examined a few of the considerations bearing upon the ideas of personality prevalent among occidental peoples and we have tried to outline some of the more familiar and tangible of the elements to be discerned in the consciousness of self. The whole book, however, is nothing but a sketch of the means and methods by which intelligence organizes conduct and develops character. The result of this process taken in its entirety at any given moment is the real living self, which the reader will find most fruitful for both his practical and his theoretical interests.

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